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RCRA FACILITY INVESTIGATION QUALITY ASSURANCE PROJECT PLAN PHASE III SOILD
SOLID WASTE MANAGEMENT UNIT 7 (SWMU7) VOLUME 1 TEXT WITH TRANSMITTAL
NSA CRANE IN
10/1/2000
TETRA TECH


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PITT-10-0-011

October 17, 2000

Project Number 7829

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 Department of the Navy
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 Attn: Mr. Bill Gates RPM Code 1873
 P.O. Box 190010
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Reference: CLEAN Contract No. N62467-94-D-0888
 Contract Task Order ~~050~~

**Subject: Final Phase III Soils RFI Quality Assurance Project Plan (QAPP) for SWMU
 7**

Dear Mr. Gates:

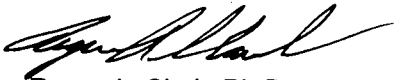
Enclosed please find one (1) copy of the above-listed planning document for the Old Rifle Range (SWMU 7) at the NSWC Crane. At your request, I have also sent eight (8) copies of this QAPP to Mr. Tom Brent at NSWC Crane.

While reviewing this document, please note the following:

- The analytical laboratory we are using for this project is Laucks Laboratory. Reporting limits and detection limits are updated periodically in accordance with project and laboratory requirements. The reason for this is to ensure continued monitoring of laboratory capabilities. The previously submitted limits have been updated since the previous submittal of the subject document. Current valid limits are provided herein and are the limits that will be used in support of the project until they are updated again.
- Please note that we have attached (three-hole punched) the U.S. EPA/IDEM comments and our responses to the February 2000 Revision 1 QAPP, to the inside of this document.
- In order to expedite the distribution of this document, I am enclosing the original signature page for you to sign and then pass along to the others for their signature. After the last person signs it, I would like that person to return the original to me. I will make copies and send to all individuals for insertion into the document.

I will contact you later this week to confirm receipt of this QAPP and to answer any questions you have. In the meantime, please call with any questions or comments. As always, you can reach me at (412) 921-8415 or 1-800-245-2730 if you have any questions regarding this correspondence.

Very truly yours,



Roger A. Clark, Ph.D.
Task Order Manager

RAC

Attachment

Cc: Mr. Tom Brent
~~Mr. Mark Perry (TtNUS) letter only~~
Mr. Mark Francis (TtNUS)
Dr. Tom Johnston (TtNUS)

**SWMU 7
Phase III Soils RFI
QAPP**

**Naval Surface Warfare Center
Crane Division**
Crane, Indiana

Volume I - Text



**Southern Division
Naval Facilities Engineering Command**
Contract Number N62467-94-D-0888
Contract Task Order 0056

October 2000

SWMU 7
PHASE III SOILS RFI QAPP

NAVAL SURFACE WARFARE CENTER
CRANE DIVISION
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT


Submitted to:
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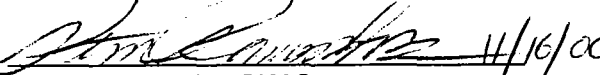
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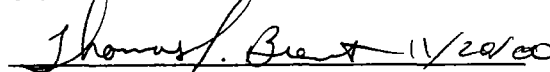
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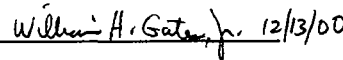
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DOUG GRIFFIN
INDIANA DEPARTMENT OF
ENVIRONMENTAL MANAGEMENT

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ACRONYMS

2,4,6-TNT	2,4,6-trinitrotoluene
2,6-DNT	2,6-dinitrotoluene
AES	Atomic Emission Spectrometry
AMSL	above mean sea level
ANOVA	Analysis of Variance
B&RE	Brown and Root Environmental
bgs	below ground surface
CAAA	Crane Army Ammunition Activity
CCCRA	Current Contamination
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
COC	Chemical of Concern or Chain of Custody, depending on context
CTO	Contract Task Order
DE	depositional environment
DEMO	Demolition Range
DOD	Department of Defense
DPT	Direct Push Technology
DQO	Data Quality Objectives
DR Army	Army demolition range
DR Navy	Navy demolition range
DRMO	Defense Reutilization and Marketing Office
EMR	Environmental Monitoring Reports
EOD	Explosive Ordnance Detachment
EPA	Environmental Protection Agency
ESM	Environmental Site Manager
EVA	Environmental Visualization System
FOL	Field Operations Leader
FTMR	Field Task Modification Request
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
GPS	Global Positioning System
HASP	Health and Safety Plan
HSM	Health and Safety Manager

IAS	Initial Assessment Study
ICP	Inductively Coupled Plasma
IDEM	Indiana Department of Environmental Management
IDL	Instrument Detection Limit
IDW	Investigation Derived Waste
LCS	Laboratory Control Sample
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
MCL	Maximum Contaminant Level
MDL	Method Detection Limit Conditions Risk Assessment
mg/kg	milligrams per kilogram
mph	miles per hour
MS	Mass Spectrometry or matrix spike, depending on context
MSD	matrix spike duplicate
NAD	Naval Ammunition Depot
NFEC	Naval Facilities Engineering Command
NFESC	Naval Facilities Engineering Service Center
NIST	National Institute of Standards and Technology
NSWC	Naval Surface Warfare Center
NTU	Nephelometric Turbidity Unit
OPR	Old Pistol Range
ORR	Old Rifle Range
%R	Percent Recovery
PAH	polycyclic aromatic hydrocarbon
PDS	Post Digestion Spike
PE	Performance evaluation
PID	Photoionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
PVC	Polyvinyl chloride
QA	quality assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control

RBSL	risk-based screening level
RBTL	risk-based target level
RCRA	Resource Conservation and Recovery Act
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RE&I	RUST Environment and Infrastructure
RFI	RCRA Facility Investigation
RL	Reporting Limit
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RQAC	RCRA Quality Assurance Coordinator
SAP	Sampling and Analysis Plan
SCS	Soil Conservation Service
SDG	Sample Delivery Group
SIM	Selective Ion Monitoring
SOP	Standard Operating Procedure
SSL	Soil Screening Level
SSO	Site Safety Officer
SWMU	Solid Waste Management Unit
TOM	Task Order Manager
TtNUS	Tetra Tech NUS, Inc.
U.S.	United States
USACE	U.S. Army Corps of Engineers
USACEWES	U.S. Army Corps of Engineers Waterways Experiment Station
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USGS	U.S. Geological Survey
UXO	Unexploded ordnance
VOCs	Volatile Organic Compounds
WP	Work Plan

1.0 PROJECT DESCRIPTION

Several consulting organizations have been involved in work associated with Solid Waste Management Unit (SWMU) 7. Brown and Root Environmental (B&RE) was purchased by Tetra Tech NUS, Inc. (Tt7NUS) on January 1, 1998. RUST Environment and Infrastructure (RE&I) was a subcontractor to B&RE and continues to be a subcontractor to TtNUS.

This Phase III soils investigation is being conducted in accordance with applicable Resource Conservation and Recovery Act (RCRA) Corrective Action requirements, including the need for RCRA Facility Investigations (RFIs) to be conducted at the Naval Surface Warfare Center (NSWC) Crane, Crane, Indiana. The investigation will provide data on select metal, polycyclic aromatic hydrocarbon (PAH), energetic material and heptachlor epoxide concentrations in NSWC Crane soils at the Old Rifle Range (ORR) (SWMU 7). SWMU 7 contains active and inactive portions.

Historical operations conducted at SWMU 7 consisted of small arms firing and open burning of ammonium picrate at the ORR (SWMU 7). These treatment and operational activities caused releases of contaminants to all environmental media. Firing of rifles and other small arms into berms and hillsides, and open burning of ammonium picrate caused releases of environmental contaminants at the ORR (SWMU 7). These land uses are expected to continue into the foreseeable future. Additional detail on historical site operations is provided in Section 1.3 of this QAPP.

Past risk assessment has indicated that humans could be exposed to unacceptable health risk caused by certain chemicals associated with operations at SWMU 7 (TtNUS, 1999a). The chemicals of concern (COCs) are presented in Table 1-1. Except for PAHs at SWMU 7, all unacceptable human health risks are associated with exposure to ground water (ingestion or dermal contact). Contaminants in the soil are presumed to be the sources of ground water contamination.

The degree of health risk to a human receptor is determined based on the frequency, duration, and nature of exposure to contaminants. Consequently it is important to understand where humans could be exposed to the contaminants.

Problem Statement

While some information on contaminated areas is available, the extent of potential soil contamination has not been completely delineated at the ORR. In order to determine the extent of contamination for completing the RFI the problem of interest is:

- Delineate the extent of soil contamination for the previously identified COCs at the ORR.

1.1 INTRODUCTION

NSWC Crane is a United States (U.S.) Navy installation located within U.S. Environmental Protection Agency (U.S. EPA), Region 5. Accordingly, this QAPP has been prepared on behalf of the United States Navy Southern Division Naval Facilities Engineering Command (SOUTHDIR) and NSWC Crane by TtNUS to comply with U.S. EPA Region 5 requirements. Those requirements, described in Section 1.1.3, govern all aspects of RCRA environmental investigations. In accordance with those requirements, project planning closely followed the U.S. EPA Data Quality Objectives (DQO) process (U.S. EPA, 1994c). That process requires explicit statements of the problem to be solved, the spatial and temporal boundaries related to the problem, the measurements to be made in solving the problem and, when applicable, quantitative specifications of the tolerances for making decision errors. It culminates in a specification of decision rules and in a sampling and analysis plan (SAP) designed to solve the stated problem.

All project planning outputs, which are typically prepared as multivolume text, have been translated into this QAPP as a stand-alone volume. As such, this QAPP describes the evaluation of existing data, and governs the collection and analysis of additional environmental samples and the associated activities required for generating chemical data to further delineate soil contamination at SWMU 7. It presents the project organization, objectives, planned activities, and specific quality assurance/quality control (QA/QC) procedures associated with sample collection and analysis for the investigation. Specific protocols for sample collection, sample handling and storage, chain-of-custody, chemical analyses, and data evaluation and assessment are described. These protocols are specified to assure the data user that the data generated during this investigation are of the expected quality.

This work was performed under Contract Number N62467-94-D-0888, Contract Task Order (CTO) Number 0056.

1.1.1 Project Objectives and Decision Statement

Past sampling has identified that contaminants are present at concentrations greater than proposed risk-based target levels (RBTLS) at SWMU 7, but that the extent of contamination has not been determined.

This investigation is designed to further delineate the extent of contamination. The decision statement for this project that will facilitate attainment of the project objective is:

Determine whether the extent of soil contamination greater than RBTLs and background concentrations has been bounded at SWMU 7. If the extent of contamination has been bounded, stop sampling; otherwise continue sampling until the extent is delineated or until two rounds of sampling are completed. If contamination is not completely delineated after two sampling rounds, consider alternative actions such as delineating the remaining contamination while implementing remedial actions.

1.1.2 Project Status/Phase

A previous ecological risk assessment did not identify any unacceptable risk to ecological receptors at this SWMU (TtNUS, 1999a). A human health risk assessment identified several COCs related to unacceptable human health risk from exposure to site contaminants (TtNUS, 1999a).

At least one round of sampling is expected for this investigation with additional sampling rounds possible. The strategy for all sampling rounds is similar. The COC concentrations will be determined and compared to appropriate RBTLs and background concentrations. The spatial region within which the soil COC concentrations change from greater than RBTLs and background concentrations to less than RBTLs and background concentrations will be defined. An underlying assumption is that contamination decreases with distance from the contamination source. Appropriate RBTLs and background concentrations are described in Sections 1.1.3 and 1.4.2, respectively.

It is assumed that no transfer of Crane ORR property is likely for at least 50 years. It is likely that any land transfers will be preceded by further site assessment because of increased contaminant concentrations resulting from continuing operations over the next 50-year time period.

Lateral sampling boundaries will be established as described in Section 1.4.2. Vertical migration of contaminants will be represented by data from surface soil (0-1 foot depth interval) and subsurface soil (2-4 feet depth intervals) at all sampling locations of the ORR. The 0-1 foot interval was selected to be consistent with the work plan for the "Base-wide Background Soil Investigation for NSWC Crane" (TtNUS, 1999c). These depth intervals are also consistent with the potential land uses as identified throughout

Section 1.0. Samples will not be collected in the water table or bedrock, even if either of the water table or bedrock is encountered at depths more shallow than 4 feet at the ORR.

Migration/degradation of metals for the next 50 years is not expected to be significant; for organic compounds, the degradation is more probable and migration may be more likely.

The statistical analyses to be performed on the sample data are described in detail in Section 12.4. Section 4 presents the sampling plan design and rationale behind selecting the target number of soil samples for this project.

1.1.3 QAPP Preparation Guidelines

This QAPP has been prepared in accordance with the "U.S. EPA Region 5 QAPP Policy" (U.S. EPA, 1998), which includes instructions for preparing RCRA Investigation QAPPs. The "Example RCRA QAPP," which is included in this policy (U.S. EPA, 1998), was followed closely when developing this QAPP. Also followed closely when establishing the QA/QC requirements specified in this QAPP was the Naval Facilities Engineering Service Center (NFESC) guidance document entitled "Navy Installation Restoration Laboratory Quality Assurance Guide" (NFESC, 1996). The NFESC guidance specifies criteria for acceptable laboratory performance and monitoring of that performance. U.S. EPA human health risk-based screening levels (RBSLs) were considered in developing this QAPP, especially when selecting sampling and analysis methods to measure target analyte concentrations in the media of interest. All QA/QC procedures are structured in accordance with applicable U.S. EPA Region 5 requirements, regulations, guidance, and technical standards.

Additional guidance regarding generation of this QAPP was obtained indirectly through a formal "pre-QAPP" meeting associated with the "Base-wide Background Soil Investigation for NSWC Crane," held on 2 March 1999, at U.S. EPA Region 5 Headquarters in Chicago, Illinois. Representatives from the U.S. EPA Region 5, SOUTHDIV, NSWC Crane, and TtNUS, Inc. met to introduce and discuss outstanding technical issues at that meeting. A follow-up telephone conversation among the same parties was conducted on 14 April 1999 to resolve outstanding issues. Those issues and their resolutions, as well as responses to U.S. EPA comments dated April 20, 2000 have been incorporated into this QAPP.

Comparability of soils data between this investigation and the "Base-wide Background Soil Investigation for NSWC Crane" is an important factor in being able to interpret the data and make background comparisons. Therefore, SWMU 7 soil samples will be treated in a manner similar to those collected for the background soil investigation. Data comparability is discussed further in other sections of this QAPP.

1.2 SITE/FACILITY DESCRIPTION

This section consists of a discussion of background information, general site characteristics of the NSWC Crane facility, and physical site characteristics specific to the ORR. It discusses such topics as site location, facility size and borders, natural and manmade features, climatology, topography, local hydrology and hydrogeology, surrounding land use, and ecological communities and habitats.

1.2.1 Location

NSWC Crane is located in a rural, sparsely populated area of southern Indiana, approximately 75 miles southwest of Indianapolis, 60 miles northwest of Louisville, Kentucky, and immediately east of Burns City and Crane Village, Indiana. Most of NSWC Crane lies in the northern portion of Martin County with smaller portions in Greene, Daviess, and Lawrence Counties. The majority of the facility is covered by forest with the surrounding acreage either wooded or farmed land. A map of the NSWC Crane facility is illustrated in Figure 1-1. The location of the ORR is shown on Figure 1-2.

1.2.2 Facility/Site Size and Borders

NSWC Crane encompasses approximately 98 square miles (64,463 acres). It is bounded on the north by State Road 45/58, on the west by U.S. Route 231, and on the south by U.S. Route 50/150. NSWC Crane consists of approximately 1006 acres of improved grounds, 10,047 acres of semi-improved grounds, and 53,410 acres of unimproved grounds. Facility access is via four gates; the main gate referred to as the Bloomington Gate (No. 1) in the north, Burns City Gate (No. 2) in the west, Bedford Gate (No. 3) along the east, and Crane Gate (No. 4) at the northwest.

Old Rifle Range

The ORR occupies approximately 20 acres immediately northeast and down slope of the Demolition Range (DEMO). The site is immediately west of NSWC Crane Highway 8 in the flat-lying floodplain of Turkey Creek. Currently the ORR consists of a flat, grass-covered area bisected from north to south by a maintained gravel road. This road provides access to various ground water monitoring wells located within the ORR and to a powder burning area. The burning area is approximately one acre in size and is located in the northern part of the ORR. It is used for burning yellow D (ammonium picrate). West of the gravel road and south of the yellow D burning area are located three earthen berms which were used in the past during rifle target practice for back stops. At the extreme southern end of the ORR is a hillside

which served as the ultimate back stop for any projectiles that did not land in the other three berms. The ORR is roughly rectangular in shape and is located in Sections 26 and 35 of T5N, R4W on the Indian Springs, Indiana Topographic Quadrangle Map (USGS, 1978). An additional area of investigation, referred to in this document as the Old Pistol Range (OPR), is approximately 10 acres in size and is located immediately adjacent to the north of the ORR. For the purposes of this QAPP, the area referred to as the ORR consists of two separate areas; the maintained part of the ORR, which is referred to as the ORR, and an adjacent abandoned shooting range referred to as the OPR. Figures 1-3 and 1-5 show the outlines of the ORR and the OPR on a 1984 aerial photograph.

1.2.3 Natural and Manmade Features

The ORR consists of a cleared area located on the floodplain of Turkey Creek. Manmade features at the ORR consist of three earthen berms used as backstops for target shooting, mechanical target holders, and a chain-link fenced pad for the storage of wooden pallets used in conjunction with burning operations. The OPR contains remnants of a wooden structure that may have been used as a shelter for target shooting. One earthen berm is present at the OPR. The OPR is not maintained and therefore small trees and brush are present throughout the area.

1.2.4 Climatology

The climate in the region of NSWC Crane can be described as temperate (NOAA, 1988). Precipitation is distributed evenly throughout the year, and there is no pronounced wet or dry season for this region. Rainfall in the spring and summer is produced mostly from showers and thunderstorms. A peak rainfall of about 2 1/2 inches in a 24-hour period can be expected about once a year. Snowfalls of 3 inches or more occur on an average of two or three times per winter season.

Mean monthly temperatures for the region are shown in Table 1-2. Temperatures range from a minimum of 27.9°F in January to a maximum of 75.7°F in July. The mean annual temperature for the area is 52.6°F. The annual mean monthly distribution of rain and snow for the area is shown in Table 1-3. Annual rainfall total is about 40 inches per year with the highest mean monthly totals occurring in the late spring and in the early summer period of May through July. Snowfall averages about 23 inches a year, with most occurring in the winter months of December through February.

Long-term climatological records (NOAA, 1988) for the area indicate that the monthly prevailing wind direction is southwest during the month of April through December, then shifts to the northwest during the

months of January through March. The annual prevailing wind direction for the region is from the southwest. The annual average wind speed for the area is about 9.6 miles per hour (mph).

1.2.5 Topography

NSWC Crane is in the unglaciated area of the Crawford Uplands Physiographic Province. This province is a rugged, highly vegetated, dissected plateau bounded by the Mitchell Plain Physiographic Province to the east and the Wabash Lowland Physiographic Province to the west (Murphy and Wade, 1998). The Mitchell Plain is a low dissected limestone plateau characterized by sinkholes and karst topographic features. The boundary between the Crawford Upland and the Mitchell Plain is marked by the highly irregular, eastern facing Chester Escarpment. Springs, caverns, caves, and other solution weathering features can be found along this escarpment and on the eastern edge of the NSWC Crane facility. The boundary between the Crawford Upland and the Mitchell Plain near the western boundary of NSWC Crane is gradual (Murphy and Wade, 1998).

The terrain is predominantly rolling with moderately incised stream valleys throughout and occasional flat areas in the central and northern portions of NSWC Crane. Most of the region is covered by deciduous trees and shrubs. The elevations across NSWC Crane range from about 500 feet above mean sea level (AMSL) to about 850 feet AMSL.

The ORR occupies approximately 20 acres within the restricted zone of the DEMO. Surface elevations range from slightly over 600 feet AMSL along the west to 500 feet AMSL on the east, along Turkey Creek. The site is immediately west of NSWC Highway 8 in the flat-lying floodplain of Turkey Creek, immediately down slope of the DEMO. The site is a roughly rectangular, cleared area immediately northeast of the DEMO. A slope is located on the boundary of the western side of the ORR, although most of the site consists of a flat, grass-covered area bisected from north to south by a maintained gravel road. West of the gravel road are located three, earthen, grass-covered berms which were used in the past during rifle target backstops. At the extreme southern end of the ORR is a grass-covered hillside which served as the ultimate backstop for any projectiles that did not land in the other three bunkers.

The OPR is located in a floodplain formed from a tributary stream channel of Turkey Creek. The elevation across the OPR varies from approximately 510 feet AMSL in the south to 525 feet to the north, east and west. Much of the area along the southeast is marshland.

1.2.6 Local Geology and Hydrogeology

The following sections summarize the general geology, stratigraphy and hydrogeology of the NSWC Crane. Specific details regarding the geology and hydrogeology of the DEMO and ORR are also included. A detailed discussion of the general geology and hydrogeology of NSWC Crane can be found in the Work Plan for Base-wide Background Soil Investigation (TtNUS, 1999c).

1.2.6.1 General Geology and Stratigraphy

The geology at NSWC Crane is generally characterized by thin overburden deposits overlying bedrock. The overburden deposits range in depth from the surface down to 65 feet (Nohrstedt, et al., 1998) below ground surface (bgs). These deposits generally consist of two types: Quaternary-age unconsolidated deposits, and unconsolidated residual soil derived from the underlying bedrock. Quaternary-age deposits consist of alluvial, colluvial and glacial outwash deposits consisting of silt, sand, and gravel. Residual soils were derived from the underlying sedimentary rocks and consist of clay, silt, sand and fragmented and/or partially weathered bedrock. Bedrock underlying the NSWC Crane facility consists of sedimentary rocks from the Lower Pennsylvanian-age Raccoon Creek Group and the Upper Mississippian-age Stephensport and West Baden Groups. A detailed description of the general geology of NSWC Crane can be found in the "Base-wide Background Soil Investigation for NSWC Crane" Work Plan (TtNUS, 1999c). The generalized stratigraphic column for the NSWC Crane area is illustrated in Figure 1-4.

Using the United States Department of Agriculture (USDA)/Soil Conservation Service (SCS) soil classification system (McElrath, 1998), the soil at the ORR has been classified by soil series. Each of these soil series is defined by various soil characteristics (e.g., grain size, erosion, slope, drainage, parent material or depositional source, etc.). Within these series, various sub-classes or soil map units have been defined. Table 1-4 lists the soil series and map units present at the DEMO and ORR. The predominant soil type at the ORR and OPR is Wellston (WeC2). Both of these soil types are silty loams.

For this study the USDA/SCS soil classifications have been categorized by the depositional environment (DE). These depositional units have been fully described in the "Base-wide Background Soil Investigation for NSWC Crane" Work Plan (TtNUS, 1999c). The DE refers to the parent material and mechanism from which the soil was formed and determines the chemical and mineralogical composition of the soil (McElrath, 1998). Grain size can also affect the chemical and mineralogical make-up of a soil or be reflective of the mineralogy. DE and soil grain size will therefore be used to characterize the soils collected as part of this investigation.

Geology of the Old Rifle Range and Old Pistol Range

This geology description of the ORR is based on information provided in the Confirmation Work Report of April 1984 for Demolition Area/Old Rifle Range conducted by the U.S. Army Corps of Engineers (Dunbar, 1984). The geology is composed of residual soils formed by weathering of the underlying parent rock, unconsolidated alluvium, and Pennsylvanian- and Mississippian-aged sedimentary rock. Soil thickness ranges from less than 2 feet to a maximum of about 30 feet bgs. The northern portion of the site is covered with occasionally flooded Burnside loam, the western portion with Wellston silt loam, and the eastern portion with frequently flooded Haymond silt loam (McElrath, 1988). The variability of soil thickness at the ORR reflects the erosional effects of the ancestral Turkey Creek and its tributaries. The thickest soil corresponds to areas of deepest fluvial incision of the rock surface and subsequent alluvial (stream-deposited) and colluvial (slope debris) filling of the Turkey Creek Valley.

The sedimentary rock underlying the ORR is Mississippian-age sandstone from the Big Clifty Formation of the Mississippian-age Stephenson Group.

1.2.6.2 Hydrogeology

Ground water in the unglaciated southwestern portion of Indiana, in general, is contained in joint openings of limestone and sandstone aquifers. Aquifers are generally isolated from one another vertically by less permeable shale units. Ground water enters the aquifers through outcrops and infiltration, and flows by gravity down the dip of the strata or locally in directions controlled by the potentiometric gradient.

Regionally, ground water flow is expected to conform to the southwestward-dipping bedrock with a gradient approaching the dip. Locally, ground water flow is likely to parallel the surface drainage on the installation. Wells installed for the ground water monitoring network generally showed this ground water flow agreed with local drainage. Seasonal fluctuations in the water table are expected to be slight because precipitation is well-distributed throughout the year (Murphy, 1994; Murphy and Wade, 1998).

Hydrogeology of the Old Rifle Range

The hydrogeology of the ORR was based on information provided in the Confirmation Work Report of April 1984 for Demolition Area/Old Rifle Range conducted by the USACE (Dunbar, 1984). During well installation by the USACE, ground water was encountered in fractures in the sandstone at the northern end and in the overburden at the southern end of the ORR. The uppermost occurrence of ground water is within the alluvium, which is present over much of the ORR. Ground water elevations within the

underlying Big Clifty-Beech Creek aquifer are similar to those in the alluvium. The two units are hydraulically connected and considered one unconfined aquifer in this area (Murphy and Wade, 1998). The occurrence and movement of ground water is closely tied to the bedrock surface (USACE, 1991). Ground water elevations within the site range from approximately 510 to 495 feet MSL, a difference of 15 feet. Flow direction is predominantly toward the east.

According to the USACE, laboratory classification of soils range from brown to tan clayey sand (SC) to clay (CL and CH). Soil permeability from a clay (CL) soil was calculated to be 2.77×10^{-6} cm/sec (based on 79% of the samples from this site).

1.2.7 Surrounding Land Use

The rural communities surrounding NSWC Crane are in transition from an economic base of agriculture, mining, and quarrying to an economy built on manufacturing and service industries. The patterns of settlement, population statistics, and median income are similar throughout the region (TtNUS, 2000). Because most of the region is covered by vegetation, the area is classified as rural (TtNUS, 2000).

There is no state or local planning within the vicinity of NSWC Crane. The only zoning and land use regulations are in the municipalities in the region. None of the municipalities are close enough to have an impact on NSWC Crane. None of the areas adjacent to NSWC Crane are zoned, and zoning is not anticipated in the near future. There are no known land use or community actions under consideration or proposed at this time (TtNUS, 2000).

1.2.8 Ecological Communities and Habitats

A biological characterization of NSWC Crane, including a listing of plants and animals found at the facility, is presented in the Installation Assessment (U.S. Army, 1978) and the Initial Assessment Study (IAS; NEESA, 1983), and is summarized in the Environmental Monitoring Reports (Halliburton NUS, 1992a, 1992b, 1992c). A list of the species which may inhabit NSWC Crane and are protected under the U.S. Endangered Species Act, Indiana Department of Natural Resources Heritage Data Center, or the U.S. Fish and Wildlife Service is summarized in the RCRA Facility Permit (U.S. EPA, 1995).

1.3 FACILITY HISTORY

This section provides a summary of historical site operations, and data collection and evaluation activities for the ORR. At the end of this section is a summary of the current status of the site.

1.3.1 General Operational History

NSWC Crane provides material, technical, and logistical support to the Navy for equipment, weapons systems, and expendable and nonexpendable ordnance items. The facility was commissioned on December 1, 1941 as the Naval Ammunition Depot (NAD), Burns City, to serve as an inland munitions production and storage center. In 1943, the facility name was changed to NAD Crane in honor of Commodore William Montgomery Crane, the first chief of the Navy's Bureau of Ordnance. The name changed again in 1975 to Naval Weapons Support Center to reflect the facility's growing involvement in high-technology weapons system. In 1977, the Secretary of Defense combined all conventional ammunition acquisition under the responsibility of a single service. The ammunition production and storage function was given to the Army, and the Crane Army Ammunition Activity (CAAA) was established as a Crane tenant to accomplish this task for Naval ammunition. In 1992, based on changing missions and alignment, the facility name was changed again to the Naval Surface Warfare Center Crane. The Army has assumed ordnance production, storage, and related responsibilities under the single-service management directive. All environmental activities on the installation, including permitting activities, remain the responsibility of the Navy. Although ordnance production and storage still resides on Base, NSWC Crane serves a modern and sophisticated Navy as a recognized leader in diverse and highly technical product lines, such as microwave devices, acoustic sensors, small arms, microelectronics technology, and more. The Army currently exists as a tenant activity on the Base as do all major branches of the Department of Defense (DOD), including the Coast Guard and the Defense Reutilization and Marketing Office (DRMO).

1.3.2 Old Rifle Range Operational History

1.3.2.1 ORR

The ORR has been in use since the early 1940s. During the 1940's, it was utilized as a practice firing range for small caliber arms. In the 1950's and 1960's, the range was used primarily for flashing material associated with explosives. Flashing was performed on the ground with the energetic material in contact with the soils. In the 1970's, this area was used for the test firing of flares and other pyrotechnic items, again in contact with the soils. Tests were also conducted by detonating a charge of high explosive on a sheet of metal. Explosive residue and fragments may have been dispersed in radial patterns from, and primarily downwind of, the point of detonation.

A gravel access road bisects the ORR from north to south. The access road leads to various ground water monitoring wells located within the ORR and to a powder burning area. This Yellow D burning area, located in the northern part of the ORR, is approximately one acre in size. West of the access road

and south of the Yellow D burning area, are located three earthen berms which were used as back stops during rifle target practice. At the extreme southern end of the ORR is a hillside which served as the ultimate back stop for any projectiles that did not strike one of the other three berms.

In early 1980, three plastic-lined shallow pits were constructed for burning bulk explosives and pyrotechnics. Around 1984, metal pans measuring 14 feet long by 7 feet wide by 1 foot deep were installed on top of the existing lined pits. No surface preparation of the burn areas occurred prior to the installation of the pans. Solid bulk propellant and explosives were open-burned (thermally treated) in three clay-lined steel pans at the ORR. The pans had aluminum lids for use when the pans were not in operation.

Open burning begins with pouring and spreading of the propellant/explosive uniformly over the burn pan and is followed by remote ignition. After combustion, ash is cleaned out of the burn pan and any pop out (ejected material) is collected for disposal (TtNUS, 1999a). The average burn time for 9,000 pounds of ammonium picrate (Yellow D) projectiles is approximately two hours, while 500 pounds of bulk Yellow D will burn in each of three pans for up to four hours. This provides ample time for aerial dispersal of combustion products. Such products may include steam, carbon dioxide, carbon monoxide, nitrogen, nitrogen oxides, finely divided uncombusted propellant/explosive, and other chemical combustion products, depending on the material being burned and the completeness of combustion. Individual burn duration varies depending on moisture or other inert material content. Metal scrap collected from the DEMO is also flashed in this area to assure complete deactivation of any residual explosives which may have remained on or within the material. Thus, metal contaminants may also be vaporized and released during combustion operations. The quantities of materials that have been released under normal operations has not been estimated.

In 1997, three concrete-lined burn pads were constructed at the ORR for the flashing and thermal treatment of Yellow D projectiles, bulk Yellow D and suspect explosive-contaminated materials. Installation of these concrete pads occurred over the preexisting burn areas, again with no remediation of the underlying soil conducted. The original liners beneath the burn areas are still in place, however.

The concrete burn pads have 18-inch high sidewalls with an 8-inch thick reinforced concrete floor sloped toward the center, where a graded collection system directs any precipitation to a collection sump. The floors of these concrete pads are covered with 6 inches of sand to prevent damage due to the intense heat of the burning operations. If necessary, uncontaminated and untreated lumber (dunnage) is added to the pads to facilitate combustion. Strict procedures are enforced to prohibit the use of

pentachlorophenol-treated materials as dunnage, thus reducing the potential for forming chlorinated organic combustion products.

1.3.2.2 OPR

Very little is known of historical operations at the OPR other than it was used for pistol training. The OPR apparently had two target ranges used for small caliber weapons and a wooden frame structure which may have served as a shelter for the marksmen. One of the ranges at the OPR was oriented east-west and used the side of a hill as a backstop. A stationary target platform constructed from metal pipes extended approximately 20 feet parallel to this hillside. During firing operations, the marksmen apparently stood close to or within the wooden structure and fired toward the west at a target located in front of the hillside. Spent cartridges may have been ejected onto the ground and then put into containers within the shed or into 55-gallon drums that are still present at the site. The second firing range at the OPR was oriented roughly north-south and used a manmade earthen berm as a backstop. No evidence of a permanent target holder is present at this range. During firing operations, the marksmen apparently stood close to the wooden shed and fired to the north into the berm. Currently, the area is vegetated and in an "unmaintained" condition. Figure 1-5 shows a generalized layout of historical operations.

1.3.3 Evaluation of Historical Data

Numerous environmental investigations have been conducted at the ORR over the past 10 years. A detailed, chronological presentation of these investigations and other relevant activities is provided in Appendix A. Soil and ground water have been sampled and a risk assessment was conducted. Figures 1-6 and 1-7, respectively, show historical soil and ground water sample locations at the ORR. The risk assessment is documented in the Current Contamination Conditions Risk Assessment (TtNUS, 1999a). Certain background data were considered to be suspect during the historical investigations because the background concentrations of certain metals were greater than SWMU concentrations for the same metals. Furthermore, it was discovered that very little of the historical analytical data had undergone a sufficiently rigorous data validation to meet the minimum data usability standards for risk assessment. The U.S. EPA and its contractor investigated this situation by conducting detailed data assessments. They determined that certain data sets should be rejected. For example, the USACE laboratory non-explosives soils data for the ORR were rejected because of incomplete QC documentation. Some resampling was conducted for the CCCRA, but most rejected data were not completely replaced as part of this resampling. Table 1-5 presents all of the data used in the CCCRA for SWMU 7.

Because of the questionable or unknown quality of much of the data from past investigations, little of the data has been used for planning this Phase III RFI. However, the rejected metals data were used as markers for other COCs to provide an initial estimate of the extent of chemical contamination at the ORR. This initial estimate was used to select locations for collecting additional soil samples. The rejected metals data were judged to be usable in this regard for the following reasons:

- Rather than being of known poor quality, the data were rejected because their quality is wholly or partially undocumented. Thus, the data could actually be of satisfactory quality.
- The selection of sampling locations is an inexact undertaking and relies heavily on professional judgment. The rejected metals data add objectivity to that judgment by providing numerical concentration estimates.
- Review of the sampling locations based on the rejected data appear to be reasonable for this project (See Section 4).
- If any more than a single round of soil samples must be collected, the data from the first round of sampling will be used as a basis for selecting the subsequent sampling locations.

1.3.4 Current Site Status

Out of the 1999 CCCRA came a list of COCs for the ORR (Table 1-1).

A site visit was conducted on March 4, 1998 to identify information needed to complete the RFI Work Plan for soils at the ORR. Conclusions from that visit are as follows:

- The Environmental Site Manager (ESM) also confirmed that soil data are needed to characterize potential contamination in the soils of the OPR backstop, the hillside to the west of the pistol range firing line, soils close to the 55-gallon drums, and the upper reaches of the hillside behind the final concrete-reinforced backstop/target mechanism located on the south end of the rifle range. Also, additional soil samples may be needed on, and at the base of, the berms in the main area of the range.

In a teleconference held on May 4, 1999 among TtNUS, the Navy and the U.S. EPA Region 5, a draft of Section 1 of this QAPP was discussed. During that teleconference, the list of 12 COCs for the ORR was

confirmed to be accurate and comprehensive for this project. This final list of project target analytes is presented in Table 1-6.

The U.S. EPA Region 5 indicated during the May 4, 1999 teleconference that all concerns regarding other contaminants had been addressed by virtue of the completed CCCRA conducted by RE&I. Specific conclusions for this site are as follows:

SWMU 7 – Old Rifle Range

The extent of contamination is the primary issue at the ORR, which includes the OPR located to the north of the ORR proper. This area has not been investigated and was recently identified as having pistol shooting operations. The 1966 aerial photographs and site inspection clearly indicate this as a possibility. This QAPP addresses the need for investigation in this area.

1.4 INTENDED DATA USES

This section provides a detailed description of the project target parameters and intended data uses.

1.4.1 Project Target Parameters

Project target parameters are presented in Table 1-6 for each area being investigated. All parameters listed are critical to the success of the project.

All field and laboratory target parameter results greater than or equal to reporting limits (RLs) will be reported. RLs for field parameters are based upon instrument or test kit capabilities and specifications. Analytical results for Table 1-6 analytes that are less than applicable RLs will be reported with a “U” flag. The “U” flag signifies that the sample was analyzed for the analyte but that the analyte was not detected at a concentration greater than or equal to the RL. The RLs are based in part on best professional judgment and also on statistical computations for determining method detection limits (MDLs) in accordance with 40CFR Part 136, Appendix B (for organic analytes), or instrument detection limits (IDLs) in accordance with the U.S. EPA Contract Laboratory Program (for metals). Sample-specific RLs will be computed for each sample to account for variations in the RL that are caused by factors such as sample moisture content, the size of the sample aliquot used in the analysis, and dilutions. The sample-specific RLs represent the lowest analyte concentrations that can be reported with confidence that the reported value approximates the true value.

1.4.1.1 Field Parameters

Several field measurements will be made for this investigation, all of which are classified as critical. The success of the project rests on the ability to acquire the desired critical measurements.

Soil grain size and depth are classified as critical parameters because they will be necessary for successful interpretation of project data.

Table 1-7 presents the RLs for the ground water target parameters measured in the field.

1.4.1.2 Laboratory Parameters

Laboratory analyses will be used to estimate target analyte concentrations in soils. The target analytes are those identified in the CCCRA (TtNUS, 1999a) as COCs.

Use of target analyte data for decision making is described in Sections 1.4.2 and 12.4.

Part of the data use includes comparisons of metal concentrations at the ORR to soil background concentrations. However, the background concentrations will not be known until the "Base-Wide Background Soil Investigation for NSWC Crane" is completed. This investigation is in the final stages of completion and the data produced should be available for comparison purposes in the current soils investigation at the ORR.

The data use also requires comparison of the analytical data to human health RBTs, which are action levels derived from RBSLs. In general, the RBT is the lowest (i.e., most conservative) RBSL. Exceptions to this rule do exist when the lowest measurable analyte concentration using best available routine analytical technology is greater than the lowest RBSL. This is explained further in the following paragraphs. Table 1-7 provides a list of the laboratory parameters, laboratory detection and reporting limits, RBSLs, and RBTs for water and soil. Tabular presentations of the criteria used as a basis for determining the RBSLs for soil is provided in Table 1-8. The following is a list of those risk-based criteria:

Soil Criteria

- U.S. EPA Generic Soil Screening Levels (SSLs) for Ingestion, Inhalation and Migration to Ground Water (U.S. EPA, 1996a)

- U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Residential and Industrial Land Use (U.S. EPA, 1999b)

TtNUS worked closely with the subcontracted analytical laboratory to select and optimize analytical methods in an effort to attain, to the greatest extent possible, laboratory RLs that are less than or equal to the lowest RBSLs. For example, PAHs will be quantified using SW-846 Method 8270C with selective ion monitoring (SIM) to achieve reporting limits that are less than the lowest RBSLs. Another example of the efforts undertaken to achieve similar performance improvements is the use of SW-846 Method 6020 (inductively coupled plasma [ICP]/mass spectrometry[MS]) in place of SW-846 Method 6010B (ICP/atomic emission spectrometry [AES]) for selected metals.

Despite the efforts to achieve RLs that are less than or equal to the lowest RBSLs for all analytes, the RLs for arsenic, 2,6-dinitrotoluene (2,6-DNT), RDX and 2,4,6-trinitrotoluene (2,4,6-TNT) in soil do not meet the associated RBSLs. The RLs for these chemicals are marked with an asterisk (*) on Table 1-7. The problem of metal RLs being greater than lowest RBSLs was discussed during the Pre-QAPP meeting for the NSWC Crane Background Soil Investigation held at U.S. EPA Region 5 Headquarters on March 2, 1999. This QAPP also addresses the determination of metal concentrations in soils, so the previous discussions held for the background study are viewed to be relevant for this investigation. The problem of organic chemicals exceeding risk-based target levels has also been raised in past discussions with U.S. EPA Region 5 representatives. The following text summarizes the rationale for using the analytical methods established in this QAPP and presented on Table 1-7.

A routine mass spectrometric/SIM analysis technique is not available for 2,6-DNT, RDX and 2,4,6-TNT. The RLs in Table 1-7 for 2,6-DNT, RDX and 2,4,6-TNT are the lowest achievable RLs under routine analytical conditions, yet they are greater than the lowest RBSLs. This situation is not reconcilable. Consequently, the RLs for those analytes in soil will be used as the RBTLs (action levels) for establishing extent of contamination at the ORR.

Past data suggest that arsenic concentrations will exceed the lowest soil RBSLs significantly, so a soil RL greater than the lowest soil RBSL is not expected to be problematic.

1.4.2 Decision Rules

The understanding of the site as described above and the DQO process outputs to this point are consolidated in this section into succinct descriptions of how the data will be used for this SWMU.

1.4.2.1 Definition

The decision rule is a statement which integrates DQO planning process outputs into a concise summary of how data will be interpreted when making decisions about the site being investigated. The decision rules form a basis for establishing a sampling plan design that will enable data of the correct type, quantity and quality to be collected for attaining project objectives. Where kriging is incorporated into the decision rule, it is understood that the kriged surface indicates the three-dimensional perimeter at which the soil contamination is greater than the indicated action level (described below).

In the discussions following, all references to soil background concentrations for metals refer to the mean background concentrations to be determined under the "Base-wide Background Soil Investigation for NSWC Crane" which is currently in progress. Background soil comparisons will consider the soil sample depositional area, grain size and depth. The action level will be determined as described in the following:

- Site soil metals data will be compared to corresponding metals data from the NSWC Crane Basewide Soil Background Study for soils of similar depositional environment (DE), depth and grain size. The comparison will make use of the non-parametric Wilcoxon Rank Sum test at a 5% significance level. Using the Wilcoxon Rank Sum test, if site data are classified as representing a population having a concentration greater than the corresponding background population, soil in these locations will be classified as "contaminated." This comparison will be henceforth be described as "> background action level concentration" or "< background action level concentration".

1.4.2.2 SWMU 7, ORR (OPR/ORR) Decision Rule

This decision rule applies to each area within SWMU 7 that is under investigation, namely, the OPR, and the burn pan area and the berm area, collectively referred to as the ORR:

If, in the first round of sampling the contamination boundary associated with SWMU 7 is not attained (i.e., at least one COC concentration is greater than the background action level concentration AND the RBTL in the first round of sampling based on kriging at 50 percent confidence), collect another round of samples. If, after a second round of sampling, the contamination boundary is not attained based on kriging (i.e., concentration is greater than the background action level concentration AND RBTL still exceeded), discuss alternative actions with the Navy and U. S. EPA Region 5. If the contamination boundary is reached (i.e., COC concentration < background action level concentration OR RBTL) within n sampling rounds, stop sampling and write a RFI report with appropriate recommendations. The stopping

rule will be “kriged COC concentration < background action level concentration OR RBTL” for all COCs in all samples.

Samples will not be collected from bedrock or from beyond the ORR boundary without discussions among TtNUS, the Navy, and U.S. EPA Region 5.

1.5 SCHEDULE

Figure 1-8 depicts the proposed schedule for QAPP completion and proposed field activities.

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TABLE 1-1
CHEMICALS OF CONCERN IDENTIFIED
THROUGH HUMAN HEALTH RISK ASSESSMENT AT THE ORR
NSWC CRANE, CRANE, INDIANA

Chemicals of Concern at ORR SWMU 7
METALS
Arsenic ⁽¹⁾
Beryllium ⁽³⁾
Manganese ⁽¹⁾
ENERGETICS
2,4,6-Trinitrotoluene ⁽¹⁾
2,6-Dinitrotoulene ⁽¹⁾
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) ⁽¹⁾
POLYCYCLIC AROMATIC HYDROCARBONS
Benzo(a)anthracene ⁽¹⁾
Benzo(a)pyrene ⁽²⁾
Benzo(b)fluoranthene ⁽²⁾
Dibenzo(a,h)anthracene ⁽²⁾
Indeno(1,2,3-cd)pyrene ⁽²⁾
ORGANOCHLORINE PESTICIDES
Heptachlor Epoxide ⁽¹⁾

- 1 Based on ingestion of ground water
- 2 Based on ingestion of beef and milk
- 3 Based on dermal contact with ground water

TABLE 1-2
CLIMATOLOGICAL
MEAN MONTHLY TEMPERATURES*
NSWC CRANE, CRANE, INDIANA

Month	Mean Monthly Temperature (°F)
January	27.9
February	30.6
March	40.3
April	52.0
May	62.5
June	71.7
July	75.7
August	73.6
September	66.8
October	55.3
November	42.0
December	31.8
Mean Annual	52.6

* Reference: NOAA, 1988.

°F - degrees Fahrenheit

TABLE 1-3
CLIMATOLOGICAL MEAN MONTHLY RAINFALL
AND SNOWFALL AMOUNTS*
NSWC CRANE, CRANE, INDIANA

Month	Mean Monthly Rainfall (inches)	Mean Monthly Snowfall (inches)
January	2.89	6.3
February	2.52	5.9
March	3.78	3.5
April	3.66	0.5
May	3.93	T ⁽¹⁾
June	4.06	0
July	3.89	0
August	3.28	0
September	3.11	0
October	2.68	T ⁽¹⁾
November	3.21	1.9
December	2.95	4.8
Annual	39.98	23.0

* Reference: NOAA, 1988.

1 Indicates snowfall amounts less than 0.01 inch.

TABLE 1-4
SOIL TYPES AT ORR
NSWC CRANE, CRANE, INDIANA

SWMU No.	SWMU Name	Abbreviated Name	Soil Type	Approximate Percentage
07/09	Old Rifle Range	ORR	WeC2	80
			Bu	15
			WeD2	10

TABLE 1-5

**ORR HISTORICAL SOIL DATA USED IN THE RISK ASSESSMENT
NSWC CRANE, CRANE, INDIANA
PAGE 1 OF 5**

fraction	parameter	risk group	sample_dat	location	nsample	result	qual	units	ourresult
M	ALUMINUM	BACKGROUND	//	CR95-07SS-A01	CR95-07SS-A01-01	4320	J	MG/KG	4320 J
M	ALUMINUM	BACKGROUND	//	CR95-07SS-A02	CR95-07SS-A02-01	4250	J	MG/KG	4250 J
M	ALUMINUM	BACKGROUND	//	CR95-07SS-A03	CR95-07SS-A03-01	4480	J	MG/KG	4480 J
M	ARSENIC	BACKGROUND	//	CR95-07SS-A01	CR95-07SS-A01-01	6.5		MG/KG	6.5
M	ARSENIC	BACKGROUND	//	CR95-07SS-A02	CR95-07SS-A02-01	7		MG/KG	7
M	ARSENIC	BACKGROUND	//	CR95-07SS-A03	CR95-07SS-A03-01	7.1		MG/KG	7.1
M	BERYLLIUM	BACKGROUND	//	CR95-07SS-A01	CR95-07SS-A01-01	0.62		MG/KG	0.62
M	BERYLLIUM	BACKGROUND	//	CR95-07SS-A02	CR95-07SS-A02-01	0.52		MG/KG	0.52
M	BERYLLIUM	BACKGROUND	//	CR95-07SS-A03	CR95-07SS-A03-01	0.73		MG/KG	0.73
M	MANGANESE	BACKGROUND	//	CR95-07SS-A01	CR95-07SS-A01-01	1210	J	MG/KG	1210 J
M	MANGANESE	BACKGROUND	//	CR95-07SS-A02	CR95-07SS-A02-01	931	J	MG/KG	931 J
M	MANGANESE	BACKGROUND	//	CR95-07SS-A03	CR95-07SS-A03-01	968	J	MG/KG	968 J
M	NICKEL	BACKGROUND	//	CR95-07SS-A01	CR95-07SS-A01-01	8	J	MG/KG	8 J
M	NICKEL	BACKGROUND	//	CR95-07SS-A02	CR95-07SS-A02-01	7.3	J	MG/KG	7.3 J
M	NICKEL	BACKGROUND	//	CR95-07SS-A03	CR95-07SS-A03-01	15.5	J	MG/KG	15.5 J
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-10-90	07/09-10-90 #1	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-10-90	07/09-10-90 #2	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/31/90	07/09-11-90	07/09/11/90 #1	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-11-90	07/09-11-90 #2	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-11-90	07/09-11-90 #3	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-11-90	07/09-11-90 #4	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-11-90	07/09-11-90 #5	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-11-90	07/09-11-90 #6	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	08/02/90	07/09-12-90	07/09/-12-90 #1	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	08/02/90	07/09-12-90	07/09/12/90 #4	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-12-90	07/09-12-90 #2	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-12-90	07/09-12-90 #3	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-1-90	07/09-1A-90 #1	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-1-90	07/09-1A-90 #2	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	07/09-1-90	07/09-1A-90 #3	250	U	UG/KG	250 U

TABLE 1-5

**ORR HISTORICAL SOIL DATA USED IN THE RISK ASSESSMENT
NSWC CRANE, CRANE, INDIANA
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fraction	parameter	risk group	sample_dat	location	nsample	result	qual	units	ourresult
EXP	2,4,6-TRINITROTOLUENE	SITE	/ /	07/09-1-90	07/09-1A-90 #5	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	08/30/90	07/09-1A-90	07/90-1A-90 #4	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	08/01/90	07/09-2-90	07/09-2-90 #1	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	08/01/90	07/09-2-90	07/09-2-90 #2	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	08/01/90	07/09-2-90	07/09-2-90 #3	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	08/01/90	07/09-2-90	07/09-2-90 #4	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	08/01/90	07/09-2-90	07/09-2-90 #5	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/26/90	07/09-3-90	07/09-3-90 #1	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/26/90	07/09-3-90	07/09-3-90 #2	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/26/90	07/09-3-90	07/09-3-90 #3	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/26/90	07/09-3-90	07/09-3-90 #4	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/26/90	07/09-3-90	07/09-3-90 #5	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/24/90	07/09-4-90	07/09-4-90 #1	199	J	UG/KG	199 J
EXP	2,4,6-TRINITROTOLUENE	SITE	07/24/90	07/09-4-90	07/09-4-90 #2	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/24/90	07/09-4-90	07/09-4-90 #3	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/24/90	07/09-4-90	07/09-4-90 #5	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	/ /	07/09-4-90	07/09-04-90 #4	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/25/90	07/09-5-90	07/09-5-90 #1	433		UG/KG	433
EXP	2,4,6-TRINITROTOLUENE	SITE	07/25/90	07/09-5-90	07/09-5-90 #2	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/25/90	07/09-5-90	07/09-5-90 #3	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/25/90	07/09-5-90	07/09-5-90 #4	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/27/90	07/09-6-90	07/09-6-90 #1	147	J	UG/KG	147 J
EXP	2,4,6-TRINITROTOLUENE	SITE	07/27/90	07/09-6-90	07/09-6-90 #2	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/27/90	07/09-6-90	07/09-6-90 #3	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/27/90	07/09-6-90	07/09-6-90 #4	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/30/90	07/09-7-90	07/09-7-90 #1	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/30/90	07/09-7-90	07/09-7-90 #2	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/30/90	07/09-7-90	07/09-7-90 #5	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/30/90	07/09-7-90	07/09-7-90 #6	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	07/30/90	07/09-7-90	07/09-7-90 #7	250	U	UG/KG	250 U

TABLE 1-5

ORR HISTORICAL SOIL DATA USED IN THE RISK ASSESSMENT
NSWC CRANE, CRANE, INDIANA
PAGE 3 OF 5

fraction	parameter	risk group	sample_dat	location	nsample	result	qual	units	ourresult
EXP	2,4,6-TRINITROTOLUENE	SITE	07/30/90	07/09-7-90	07/09/7/90 #3	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	08/03/90	07/09-8-90	07/09-8-90 #1	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	08/03/90	07/09-8-90	07/09-8-90 #2	3080		UG/KG	3080
EXP	2,4,6-TRINITROTOLUENE	SITE	08/04/90	07/09-9-90	07/09-9-90 #1	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	08/04/90	07/09-9-90	07/09-9-90 #2	250	U	UG/KG	250 U
EXP	2,4,6-TRINITROTOLUENE	SITE	//	CR95-07SS-A04	CR95-07SS-A04-01	250	UJ	UG/KG	250 UJ
EXP	2,4,6-TRINITROTOLUENE	SITE	//	CR95-07SS-A05	CR95-07SS-A05-01	2490	UJ	UG/KG	2490 UJ
EXP	2,4,6-TRINITROTOLUENE	SITE	//	CR95-07SS-A06	CR95-07SS-A06-01	250	UJ	UG/KG	250 UJ
M	ALUMINUM	SITE	//	CR95-07SS-A04	CR95-07SS-A04-01	5210	J	MG/KG	5210 J
M	ALUMINUM	SITE	//	CR95-07SS-A05	CR95-07SS-A05-01	6990	J	MG/KG	6990 J
M	ALUMINUM	SITE	//	CR95-07SS-A06	CR95-07SS-A06-01	5050	J	MG/KG	5050 J
M	ALUMINUM	SITE	//	CR9707SS-01	CR9707SS-0101-1	6690	J	MG/KG	6690 J
M	ALUMINUM	SITE	//	CR9707SS-05	CR9707SS-0501-1	5770	J	MG/KG	5770 J
M	ALUMINUM	SITE	//	CR9707SS-05	CR9707SS-0504-1	6240	J	MG/KG	6240 J
M	ALUMINUM	SITE	//	CR9707SS-05	CR9707SS-0504-2	5330	J	MG/KG	5330 J
M	ALUMINUM	SITE	//	CR9707SS-09	CR9707SS-0901-1	5940	J	MG/KG	5940 J
M	ALUMINUM	SITE	//	CR9707SS-12	CR9707SS-1201-1	6110	J	MG/KG	6110 J
M	ALUMINUM	SITE	//	CR9707SS-12	CR9707SS-1204-1	8930	J	MG/KG	8930 J
M	ARSENIC	SITE	//	CR95-07SS-A04	CR95-07SS-A04-01	6.5		MG/KG	6.5
M	ARSENIC	SITE	//	CR95-07SS-A05	CR95-07SS-A05-01	9.1		MG/KG	9.1
M	ARSENIC	SITE	//	CR95-07SS-A06	CR95-07SS-A06-01	7.1		MG/KG	7.1
M	ARSENIC	SITE	//	CR9707SS-01	CR9707SS-0101-1	3.2	J	MG/KG	3.2 J
M	ARSENIC	SITE	//	CR9707SS-05	CR9707SS-0501-1	6.9	J	MG/KG	6.9 J
M	ARSENIC	SITE	//	CR9707SS-05	CR9707SS-0504-1	5.7	J	MG/KG	5.7 J
M	ARSENIC	SITE	//	CR9707SS-05	CR9707SS-0504-2	5.8	J	MG/KG	5.8 J
M	ARSENIC	SITE	//	CR9707SS-09	CR9707SS-0901-1	5.7	J	MG/KG	5.7 J
M	ARSENIC	SITE	//	CR9707SS-12	CR9707SS-1201-1	5.8	J	MG/KG	5.8 J
M	ARSENIC	SITE	//	CR9707SS-12	CR9707SS-1204-1	8	J	MG/KG	8 J
OS	BENZO(A)ANTHRACENE	SITE	//	CR95-07SS-A04	CR95-07SS-A04-01	410	U	UG/KG	410 U
OS	BENZO(A)ANTHRACENE	SITE	//	CR95-07SS-A05	CR95-07SS-A05-01	2500		UG/KG	2500

TABLE 1-5

**ORR HISTORICAL SOIL DATA USED IN THE RISK ASSESSMENT
NSWC CRANE, CRANE, INDIANA
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fraction	parameter	risk group	sample_dat	location	nsample	result	qual	units	ourresult
OS	BENZO(A)ANTHRACENE	SITE	//	CR95-07SS-A06	CR95-07SS-A06-01	77	J	UG/KG	77 J
OS	BENZO(A)ANTHRACENE	SITE	//	CR9707SS-01	CR9707SS-0101-1	420	U	UG/KG	420 U
OS	BENZO(A)PYRENE	SITE	//	CR95-07SS-A04	CR95-07SS-A04-01	410	U	UG/KG	410 U
OS	BENZO(A)PYRENE	SITE	//	CR95-07SS-A05	CR95-07SS-A05-01	2800		UG/KG	2800
OS	BENZO(A)PYRENE	SITE	//	CR95-07SS-A06	CR95-07SS-A06-01	100	J	UG/KG	100 J
OS	BENZO(A)PYRENE	SITE	//	CR9707SS-01	CR9707SS-0101-1	420	U	UG/KG	420 U
OS	BENZO(B)FLUORANTHENE	SITE	//	CR95-07SS-A04	CR95-07SS-A04-01	410	U	UG/KG	410 U
OS	BENZO(B)FLUORANTHENE	SITE	//	CR95-07SS-A05	CR95-07SS-A05-01	3700		UG/KG	3700
OS	BENZO(B)FLUORANTHENE	SITE	//	CR95-07SS-A06	CR95-07SS-A06-01	99	J	UG/KG	99 J
OS	BENZO(B)FLUORANTHENE	SITE	//	CR9707SS-01	CR9707SS-0101-1	420	U	UG/KG	420 U
M	BERYLLIUM	SITE	//	CR95-07SS-A04	CR95-07SS-A04-01	0.85		MG/KG	0.85
M	BERYLLIUM	SITE	//	CR95-07SS-A05	CR95-07SS-A05-01	0.63		MG/KG	0.63
M	BERYLLIUM	SITE	//	CR95-07SS-A06	CR95-07SS-A06-01	0.81		MG/KG	0.81
M	BERYLLIUM	SITE	//	CR9707SS-01	CR9707SS-0101-1	1.2		MG/KG	1.2
M	BERYLLIUM	SITE	//	CR9707SS-05	CR9707SS-0501-1	0.46		MG/KG	0.46
M	BERYLLIUM	SITE	//	CR9707SS-05	CR9707SS-0504-1	0.83		MG/KG	0.83
M	BERYLLIUM	SITE	//	CR9707SS-05	CR9707SS-0504-2	1.1		MG/KG	1.1
M	BERYLLIUM	SITE	//	CR9707SS-09	CR9707SS-0901-1	0.37		MG/KG	0.37
M	BERYLLIUM	SITE	//	CR9707SS-12	CR9707SS-1201-1	1		MG/KG	1
M	BERYLLIUM	SITE	//	CR9707SS-12	CR9707SS-1204-1	0.46		MG/KG	0.46
OS	DIBENZO(A,H)ANTHRACENE	SITE	//	CR95-07SS-A04	CR95-07SS-A04-01	410	U	UG/KG	410 U
OS	DIBENZO(A,H)ANTHRACENE	SITE	//	CR95-07SS-A05	CR95-07SS-A05-01	840		UG/KG	840
OS	DIBENZO(A,H)ANTHRACENE	SITE	//	CR95-07SS-A06	CR95-07SS-A06-01	19	J	UG/KG	19 J
OS	DIBENZO(A,H)ANTHRACENE	SITE	//	CR9707SS-01	CR9707SS-0101-1	420	U	UG/KG	420 U
OS	INDENO(1,2,3-CD)PYRENE	SITE	//	CR95-07SS-A04	CR95-07SS-A04-01	410	U	UG/KG	410 U
OS	INDENO(1,2,3-CD)PYRENE	SITE	//	CR95-07SS-A05	CR95-07SS-A05-01	2200		UG/KG	2200
OS	INDENO(1,2,3-CD)PYRENE	SITE	//	CR95-07SS-A06	CR95-07SS-A06-01	81	J	UG/KG	81 J
OS	INDENO(1,2,3-CD)PYRENE	SITE	//	CR9707SS-01	CR9707SS-0101-1	420	U	UG/KG	420 U
M	MANGANESE	SITE	//	CR95-07SS-A04	CR95-07SS-A04-01	666	J	MG/KG	666 J
M	MANGANESE	SITE	//	CR95-07SS-A05	CR95-07SS-A05-01	525	J	MG/KG	525 J

TABLE 1-5

**ORR HISTORICAL SOIL DATA USED IN THE RISK ASSESSMENT
NSWC CRANE, CRANE, INDIANA
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fraction	parameter	risk group	sample_dat	location	nsample	result	qual	units	ourresult
M	MANGANESE	SITE	//	CR95-07SS-A06	CR95-07SS-A06-01	1120	J	MG/KG	1120 J
M	MANGANESE	SITE	//	CR9707SS-01	CR9707SS-0101-1	1660	J	MG/KG	1660 J
M	MANGANESE	SITE	//	CR9707SS-05	CR9707SS-0501-1	588	J	MG/KG	588 J
M	MANGANESE	SITE	//	CR9707SS-05	CR9707SS-0504-1	1150	J	MG/KG	1150 J
M	MANGANESE	SITE	//	CR9707SS-05	CR9707SS-0504-2	1200	J	MG/KG	1200 J
M	MANGANESE	SITE	//	CR9707SS-09	CR9707SS-0901-1	357	J	MG/KG	357 J
M	MANGANESE	SITE	//	CR9707SS-12	CR9707SS-1201-1	1220	J	MG/KG	1220 J
M	MANGANESE	SITE	//	CR9707SS-12	CR9707SS-1204-1	765	J	MG/KG	765 J
M	NICKEL	SITE	//	CR95-07SS-A04	CR95-07SS-A04-01	12.4	J	MG/KG	12.4 J
M	NICKEL	SITE	//	CR95-07SS-A05	CR95-07SS-A05-01	14.1	J	MG/KG	14.1 J
M	NICKEL	SITE	//	CR95-07SS-A06	CR95-07SS-A06-01	10.9		MG/KG	10.9
M	NICKEL	SITE	//	CR9707SS-01	CR9707SS-0101-1	16.7		MG/KG	16.7
M	NICKEL	SITE	//	CR9707SS-05	CR9707SS-0501-1	10.9		MG/KG	10.9
M	NICKEL	SITE	//	CR9707SS-05	CR9707SS-0504-1	15.7		MG/KG	15.7
M	NICKEL	SITE	//	CR9707SS-05	CR9707SS-0504-2	17.3		MG/KG	17.3
M	NICKEL	SITE	//	CR9707SS-09	CR9707SS-0901-1	6.1		MG/KG	6.1
M	NICKEL	SITE	//	CR9707SS-12	CR9707SS-1201-1	9.8		MG/KG	9.8
M	NICKEL	SITE	//	CR9707SS-12	CR9707SS-1204-1	7.5		MG/KG	7.5

TABLE 1-6

**SOIL TARGET PARAMETERS AT THE ORR
NSWC CRANE, CRANE, INDIANA**

Chemical of Concern	Intended Data Use
Metals	
Arsenic	To establish extent of soil contamination.
Beryllium	To establish extent of soil contamination.
Manganese	To establish extent of soil contamination.
Energetics	
2,4,6-Trinitrotoluene	To establish extent of soil contamination.
2,6-Dinitrotoluene	To establish extent of soil contamination.
RDX	To establish extent of soil contamination.
Polycyclic Aromatic Hydrocarbons	
Benzo(a)anthracene	To establish extent of soil contamination.
Benzo(a)pyrene	To establish extent of soil contamination.
Benzo(b)fluoranthene	To establish extent of soil contamination.
Dibenzo(a,h)anthracene	To establish extent of soil contamination.
Indeno(1,2,3-cd)pyrene	To establish extent of soil contamination.
Organochlorine Pesticides	
Heptachlor Epoxide	To establish presence and extent of contamination, if any.
Supporting Parameters	
Depositional Environment	This parameter is used for identifying soil sampling locations in the horizontal direction for comparison to background concentrations classified according to depositional environment.
Grain Size (soil only)	Used to establish which background data set is most comparable for background comparisons. For surface soils grain size is not as useful as it might be for other investigations because of the likelihood of blending in the surface that has taken place between surface and subsurface soils.
Sample Depth/Location	These parameters are used for identifying soil and water sample locations in the vertical and horizontal direction and will be used in kriging.

TABLE 1-7.
TARGET PARAMETER MDLs/IDLs, RLs, AND RISK-BASED TARGET LEVELS
NSWC CRANE, CRANE, INDIANA

Chemical	Aqueous QC Samples		Soil Samples			
	Laboratory MDL/IDL ⁽¹⁾ (ug/L)	Laboratory RL ⁽¹⁾ (ug/L)	Laboratory MDL/IDL ⁽¹⁾ (mg/kg)	Laboratory RL ⁽¹⁾ (mg/kg)	Lowest Risk Based Screening Level ⁽²⁾ (mg/kg)	Risk-Based Target Level (mg/kg) ⁽³⁾
ENERGETICS (SW-846 METHOD 8330)						
2,6-Dinitrotoulene	0.11	0.65	0.22*	0.5*	3E-5	0.5
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.30	0.61	0.28*	0.5*	0.0002 ⁽⁴⁾	0.5
2,4,6-Trinitrotoluene	0.16	0.65	0.14*	0.5*	0.005 ⁽⁴⁾	0.5
POLYCYCLIC AROMATIC HYDROCARBONS (SW-846 METHOD 8270C SIM)						
Benzo(a)anthracene	0.0084	0.2	0.00079	0.007	0.08	0.08
Benzo(a)pyrene	0.0124	0.2	0.0026	0.007	0.062	0.062
Benzo(b)fluoranthene	0.0168	0.2	0.0012	0.007	0.2	0.2
Dibenzo(a,h)anthracene	0.0059	0.2	0.00079	0.007	0.062	0.062
Indeno(1,2,3-cd)pyrene	0.0084	0.2	0.0010	0.007	0.62	0.62
ORGANOCHLORINE PESTICIDES (SW-846 METHOD 8081 A)						
Heptachlor Epoxide	0.0008	0.05	0.00053	0.0017	0.03	0.03
Arsenic	0.1	1.0	0.09	0.5*	0.39	0.39
Beryllium	0.048	1.0	0.03	0.5	3	3
METALS (SW-846 METHOD 6010B, ICPAES)						
Manganese	1.6	15	0.12	1.5	38 ⁽⁴⁾	38

- * Asterisk indicates those chemicals for which the laboratory detection limit or reporting limit exceeds the lowest risk-based screening level for the project.
- 1 Values provided by Laucks Testing Laboratories, Inc. IDLs apply to metals only; MDLs apply to organic chemicals only. For soil samples, IDLs and associated RLs assume 1 g of soil in 100 mL of digestate. For MDLs and RLs for organic chemicals, the values in this table are based on standard, method-specific requirements.
- 2 Value is based on human risk-based criteria as presented in Table 1-8. For this project, no ecological values are used based on the CCCRA conclusion that there are no unacceptable ecological risks at SWMU 7.
- 3 The RBTL is the lowest risk-based screening level unless the RL is greater than the lowest risk-based screening level, in which case the RBTL is the laboratory RL.
- 4 Calculated value. Refer to Table 1-8 for details.

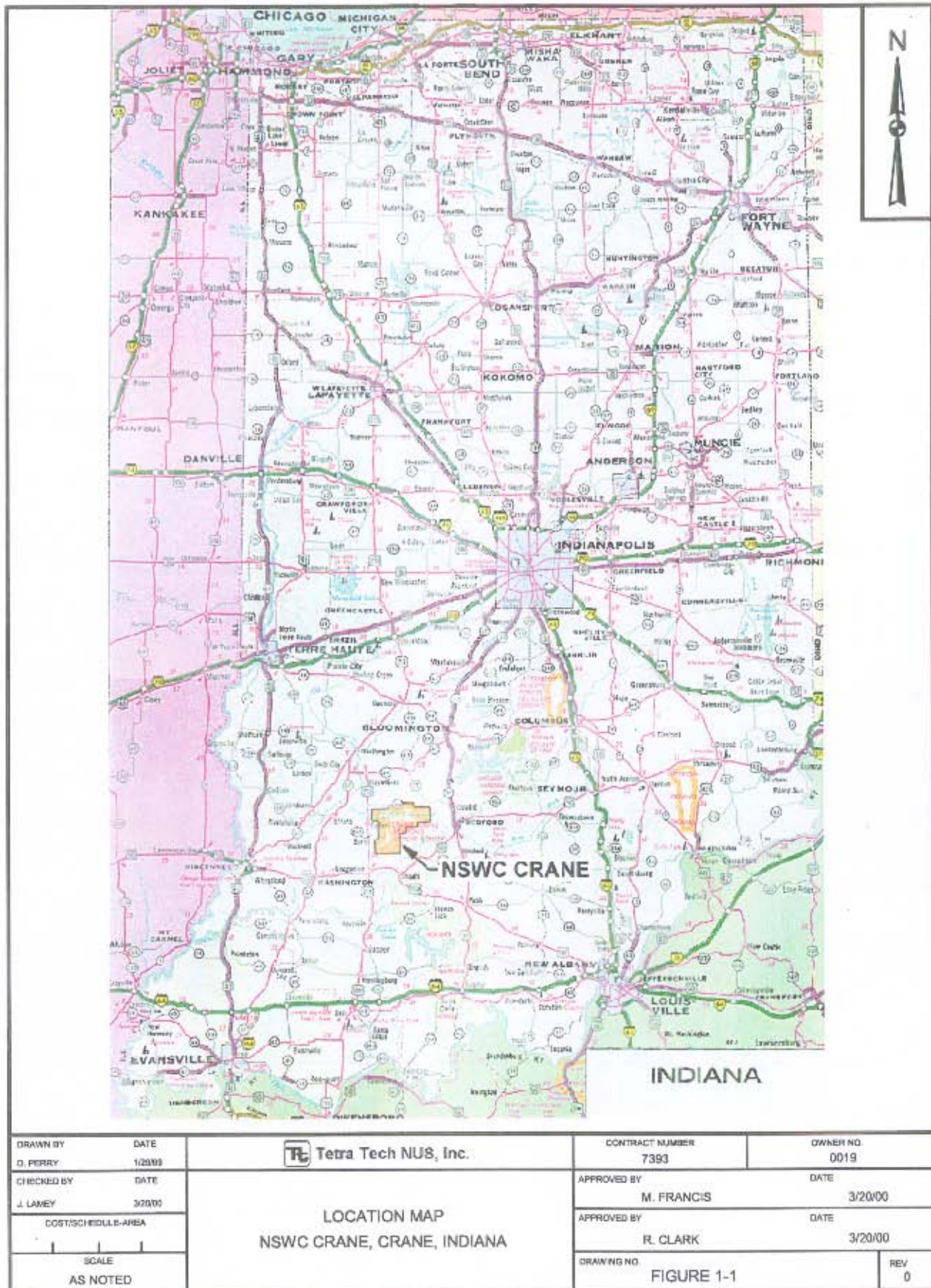
TABLE 1-8
RISK-BASED SCREENING LEVELS FOR SOIL
NSWC CRANE, CRANE, INDIANA

Chemical	U.S. EPA Generic Soil Screening Levels (SSL) ⁽¹⁾ , mg/kg			U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) ⁽²⁾ , mg/kg	
	Ingestion	Inhalation	Migration to Ground water	Residential	Industrial
2,4,6-Trinitrotoluene	21 ⁽³⁾	370,000 ⁽³⁾	0.005 ⁽³⁾	16	82
2,6-Dinitrotoulene	0.9	17,000 ⁽³⁾	3E-5	61	880
Benzo(a)anthracene	0.9	36,000 ⁽³⁾	0.08	0.62	2.9
Benzo(a)pyrene	0.09	3,600 ⁽³⁾	0.4	0.062	0.29
Benzo(b)fluoranthene	0.9	36,000 ⁽³⁾	0.2	0.62	2.9
Dibenzo(a,h)anthracene	0.09	3,600 ⁽³⁾	0.08	0.062	0.29
Heptachlor Epoxide	0.07	5	0.03	0.053	0.27
Indeno(1,2,3-cd)pyrene	0.9	36,000 ⁽³⁾	0.7	0.62	2.9
RDX	5.8 ⁽³⁾	100,000 ⁽³⁾	0.0002 ⁽³⁾	4.4	22
Arsenic	0.4	750	1	0.39	2.7
Beryllium	0.1	1,300	3	150	2200
Manganese	3,700 ⁽³⁾	67,000 ⁽³⁾	38 ⁽³⁾	1,800	32,000

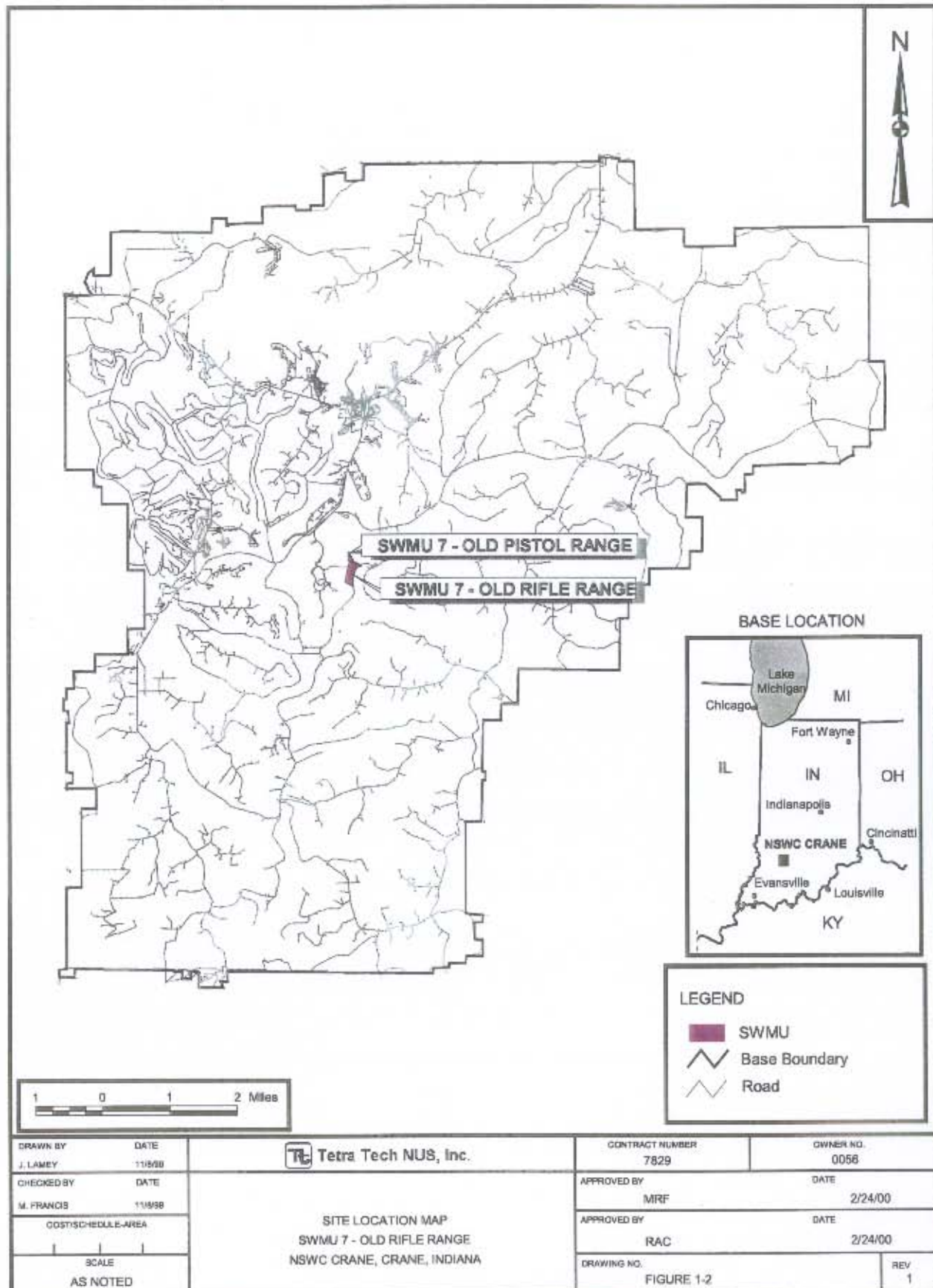
1 Unless otherwise noted, the value presented is the U.S. EPA Generic SSL (U.S. EPA, 1996).

2 U.S. EPA Region 9 PRG for soil (U.S. EPA, 1999b).

3 A value is not presented in the cited guidance. The methodology presented in the guidance was used, along with published chemical-specific parameters, to calculate a value.



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P:\G\NSWC_CRANE\7829\APR SITE LOCATION 9/27/2000 MGB




P:\GIS\NSWC_CRANE\7829\QAPP SWMU 7-SITE MAP 9/27/2000 MGS

PERIOD	EPOCH	THICKNESS (FEET)	LITHOLOGY	FORMATION	GROUP
PENN-SYLVANIAN	POTTSVILLE	150-300		MANSFIELD FM.	"RACCOON CREEK"
MISSISSIPPIAN	CHESTER	20-30		GLEN DEAN LS.	STEPHENS-PORT
		30-40		HARDINSBURG SS.	
		40-50		GOLCONDA LS.	
		25-40		BIG CIFTY FM.	
		15-25		BEECH CREEK LS.	
		20-40		ELWREN FM.	WEST BADEN
		0-5		REELSVILLE LS.	
		20-40		SAMPLE FM.	
		10-20		BEAVER BEND LS.	
	MERAMEC	12-30		BETHEL FM.	BLUE RIVER
		15-20		PAQU LS.	
		100-120		STE. GENEVIEVE LS.	
		100-120		ST. LOUIS LS.	
		90-100		SALEM LS.	SANDERS
		50-80		HARRODSBURG LS.	
	OSAGE	600-800		MULDRAUGH FM.	BORDEN

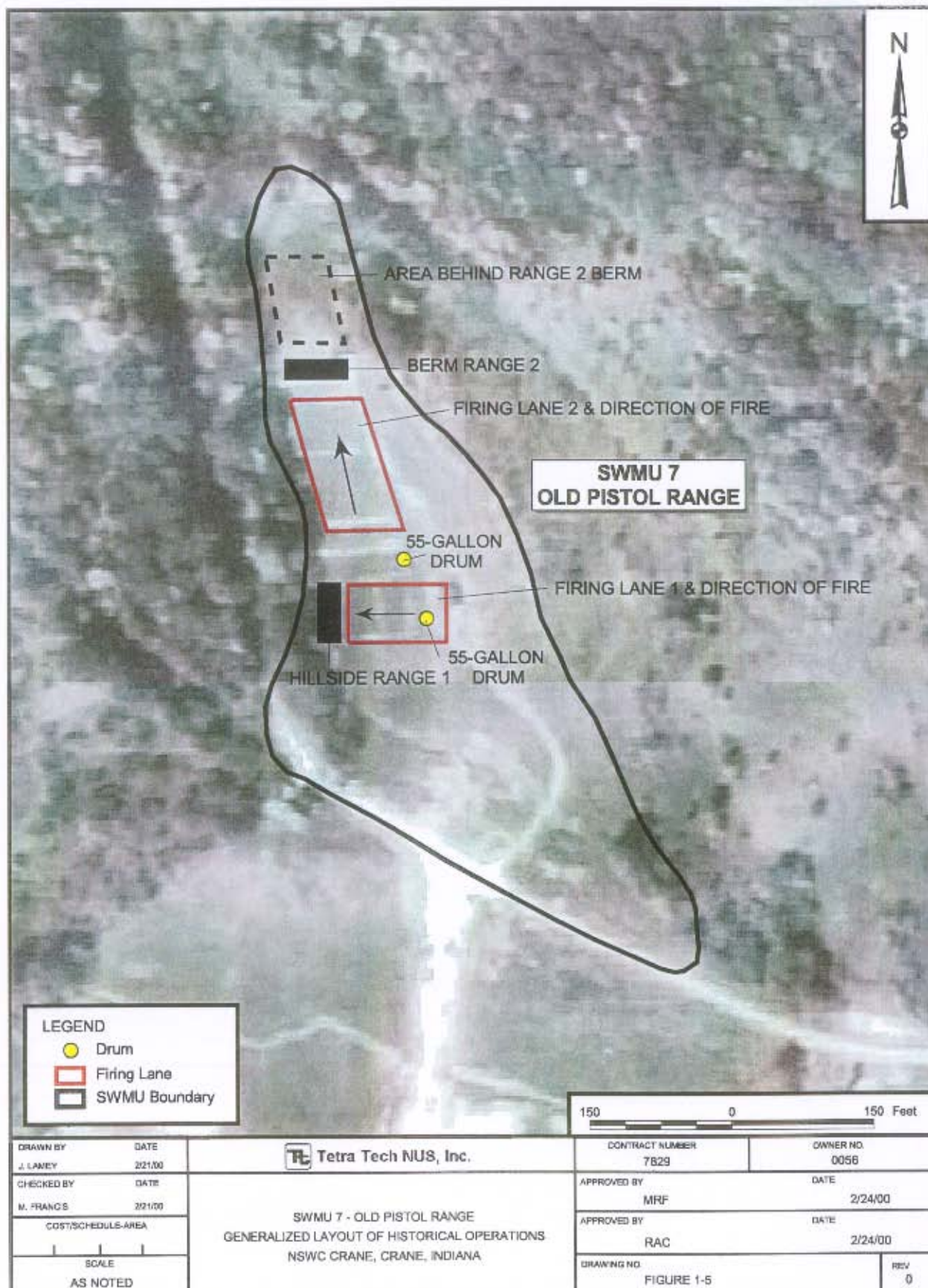
Source: Draft Report, RCRA Facility Investigation
Phase II Groundwater Release Assessment, SWMU 06/09
Demolition Area and Phase III Release
Characterization SWMU 07/09 Old Rifle Range
November 1995-Figure 11 by William L. Murphy and Roy Wade

Source: Palmer, 1969; Cited in Murphy and Wade, 1995

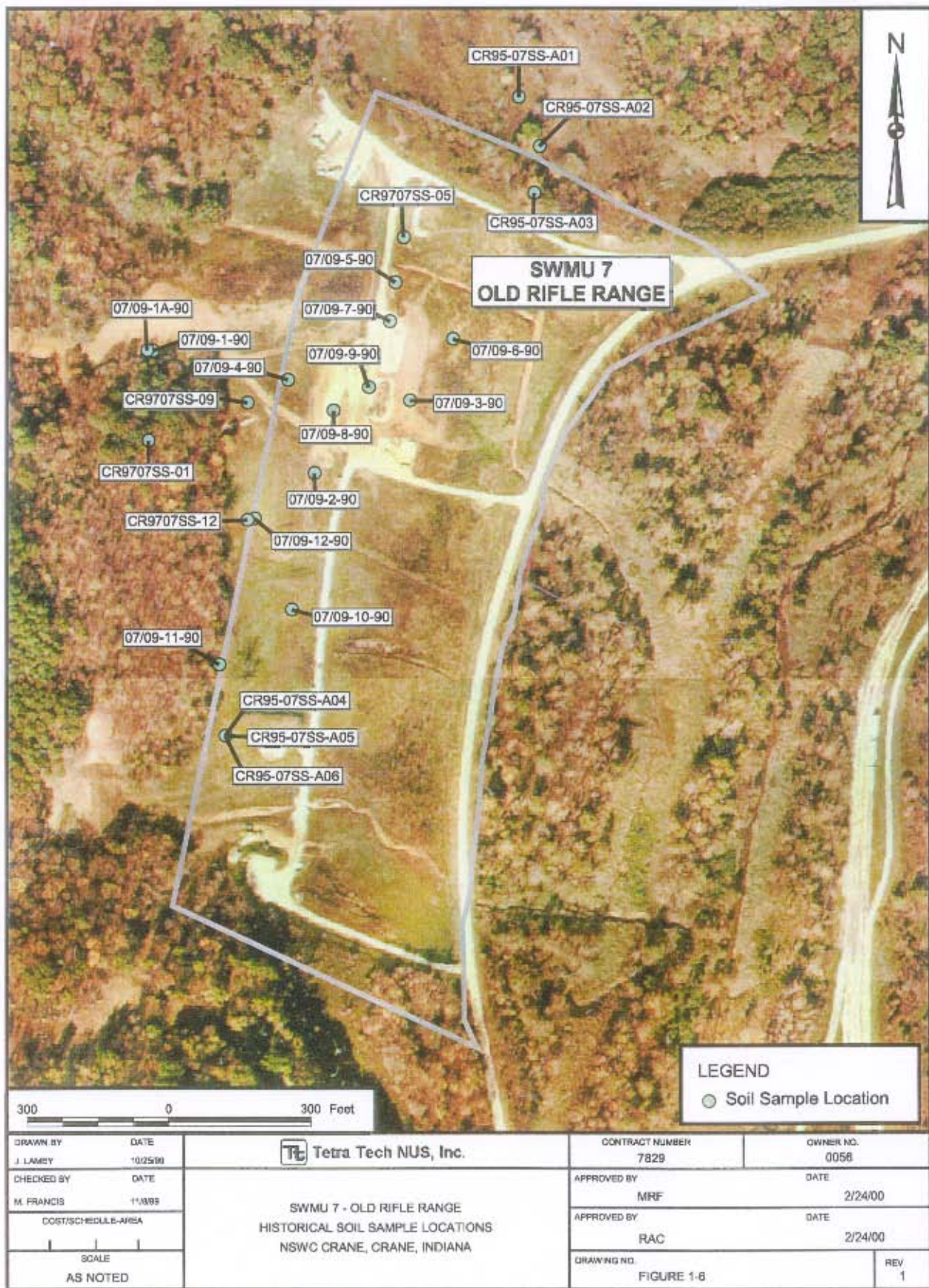
DRAWN BY J. LAMEY	DATE 11/29/99	 Tetra Tech NUS, Inc. STRATIGRAPHIC COLUMN FOR NSWC CRANE, CRANE, INDIANA	CONTRACT NUMBER 7829	OWNER NO 0056
CHECKED BY R. CLARK	DATE 2/24/00		APPROVED BY MRF	DATE 2/24/00
COST/SCHEDULE-AREA			APPROVED BY RAC	DATE 2/24/00
SCALE AS NOTED			DRAWING NO. FIGURE 1-4	REV 1

P:\GIS\NSWC_CRANE\7829.APR FIGURE 1-4 TEMPLATE 11/30/99 JAL

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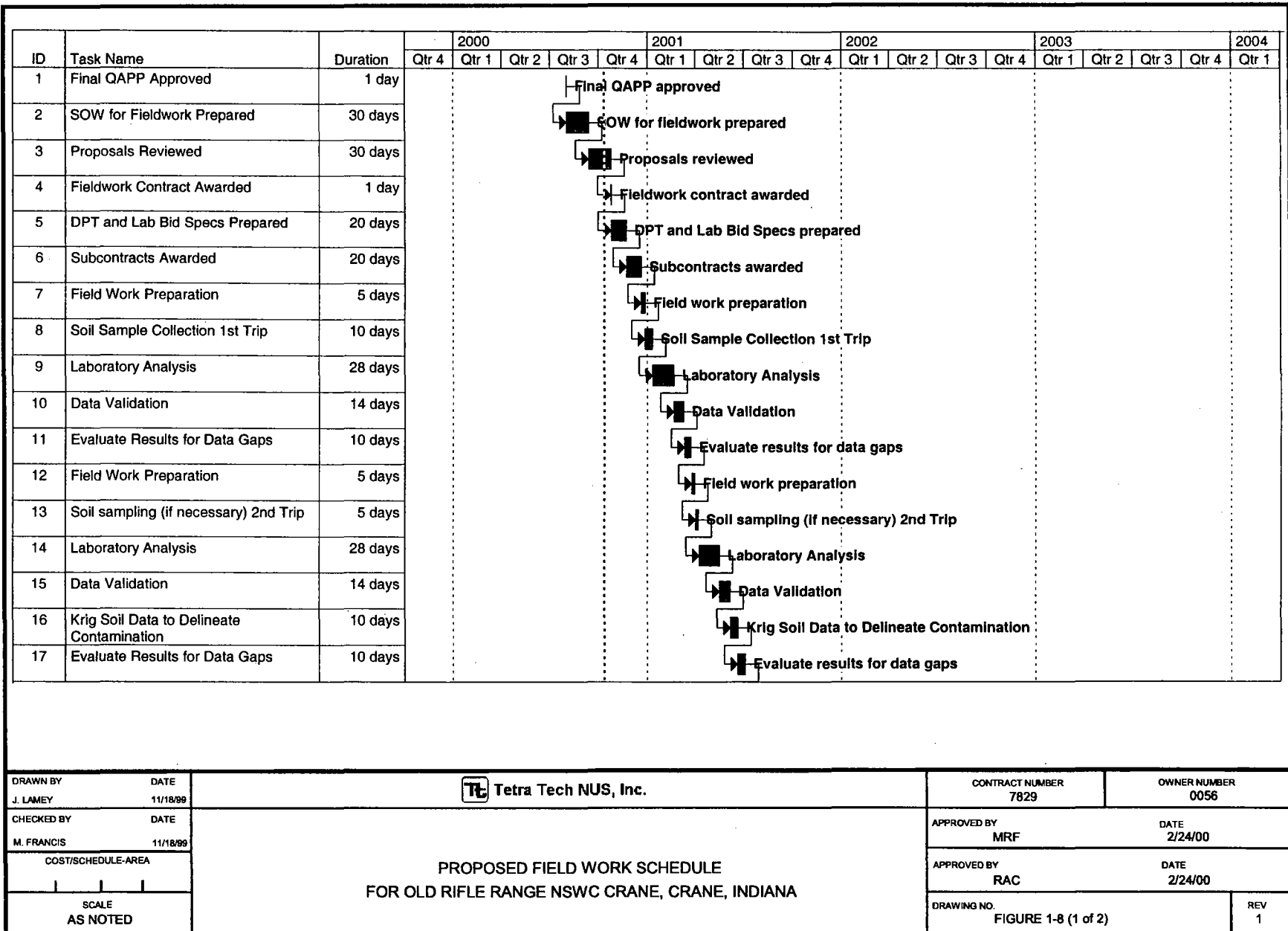
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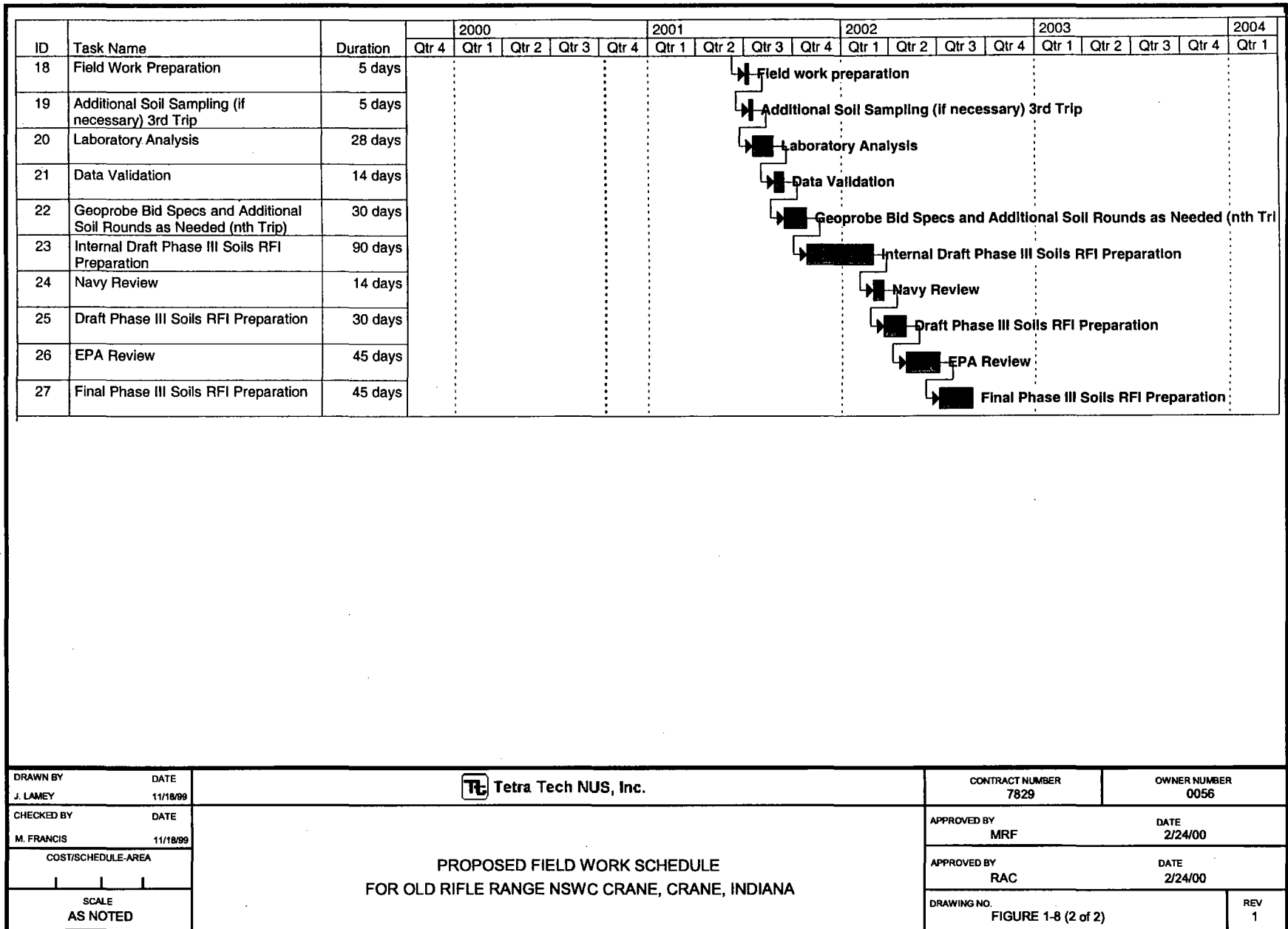
P:\GIS\NSWC_CRANE\7829.APR SWMU 7 (OLD RIFLE RANGE)-SOIL SAMPLE LOCATIONS 2/21/00 JAL



P:\GIS\NSWC_Crane\1103 APR SWMU 7 (OLD RIFLE RANGE) GROUNDWATER SAMPLE LOCATIONS 11/10/00 JAL



P:\GIS\NSWC_CRANE\7829.APR FIGURE 11 TEMPLATE 2/21/00 JAL



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2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section presents the project management and organization for this Soils RFI at NSWC Crane. Included in the following sections are the staffing and coordination requirements.

2.1 MANAGEMENT

At the direction of the U.S. EPA Project Manager, TtNUS, on behalf of the U.S. Navy, is responsible for the overall management, implementation of contract field activities, and preparation of the Phase III Soils RFI plan and report. Personnel from the Navy will be actively involved and will coordinate with TtNUS personnel in a number of areas. The authorities and organizational relationships of key personnel are depicted in Figure 2-1. Corresponding addresses and telephone numbers of key personnel are listed by organization in Table 2-1. Responsibilities for program management, project management, field operations, and laboratory operations are discussed in the following sections. It is intended that the individuals named will perform the designated responsibilities to the extent that the specific person is available to perform the stated activities.

2.1.1 U.S. EPA Project Manager

The U.S. EPA Project Manager (PM) will oversee the implementation of the Soils RFI for the ORR at NSWC Crane. The U.S. EPA PM represents the Agency's interests and will provide input from this perspective and lend general historical and technical assistance to NSWC Crane field activities.

2.1.2 Indiana Department of Environmental Management

The IDEM Corrective Action Section, Office of Land Quality will oversee the implementation of this Soils RFI from IDEM's perspective.

2.1.3 Navy Project Managers

The Navy Remedial Project Manager (RPM) acts as the focal representative for the U.S. Navy, providing management, technical direction, and oversight for all NSWC Crane project activities performed by contractors (i.e., TtNUS) and their subcontractors. In matters such as facilitation of site access, oversight, etc., the Navy RPM is assisted by the NSWC Environmental Site Manager (ESM). Additional responsibilities of the RPM are:

- Define project objectives and develop a detailed work plan schedule
- Establish project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task
- Acquire and apply technical resources (i.e., contractors) as needed to ensure performance within budget and schedule constraints
- Review the work performed on each task to ensure its quality, responsiveness, and timeliness
- Review and analyze overall task performance with respect to planned requirements and authorizations
- Approve all reports (deliverables) before their submission to U.S. EPA Region 5
- Ultimately be responsible for the preparation and quality of interim and final reports, and
- Represent the project team at meetings and public hearings

2.1.4 Contractor Project Management

Program Manager

The TtNUS Navy Southern Division Comprehensive Long-Term Environmental Action Navy (CLEAN) Program Manager provides operations, technical, and administrative leadership, and oversees and supports quality policies. The Program Manager assigns project Task Order Managers (TOMs) and oversees their performance. The Program Manager also ensures the availability of technical and support resources for program operations, and maintains consistency in procedures and projects among CTO assignments. In these matters, the PM is assisted by the TOM.

Task Order Manager

The TtNUS TOM has the overall responsibility for ensuring that the project meets U.S. EPA and IDEM objectives, and Navy and TtNUS quality standards. The TOM is responsible for the preparation and distribution of the QAPP at the direction of the Navy RPM to all parties connected with the project,

including any subcontractors. The TOM will report to the Navy RPM and is responsible for technical QC and project oversight. Additional responsibilities of the TOM are:

- Ensuring timely resolution of project-related technical, quality, safety, or waste management issues
- Functioning as primary interface with the Navy RPM and NSWC Crane Site Manager, field and office personnel, and subcontractor points-of-contact
- Monitoring and evaluating subcontractor laboratory performance
- Coordinating and overseeing work performed by field and office technical staff (including data validation, statistical evaluations, and report preparation)
- Coordinating and overseeing maintenance of all project records
- Coordinating and overseeing review of project deliverables
- Preparing and issuing final deliverables to the Navy
- Approving the implementation of corrective action

Health and Safety Manager

The TtNUS Health and Safety Manager (HSM) is responsible for the following:

- Overseeing the development and review of the Site Security and Health and Safety Plan (HASP)
- Implementing the Site Security and HASP
- Assigning the Site Safety Officer (SSO) and supervising his/her performance
- Conducting Health and Safety audits
- Preparing Health and Safety reports for management

2.2 QUALITY ASSURANCE

This section identifies the QA responsibilities for this soils RFI. Responsibilities of the U.S. EPA Region 5, TtNUS, and the analytical laboratory are discussed.

2.2.1 U.S. EPA Region 5 Quality Assurance Coordinator

The U.S. EPA Region 5 RCRA Quality Assurance Coordinator (RQAC) has the responsibility to review and approve the QAPP and provide overall QA support and review. Additional responsibilities may include:

- Coordinating external performance and system audits of the contracted laboratory
- Reviewing and evaluating analytical field and laboratory procedures

2.2.2 TtNUS Quality Assurance Manager

The TtNUS Quality Assurance Manager (QAM) is responsible for overall QA for the project, and reports directly to the TtNUS Program Manager. The QAM has the responsibility for the following specific activities:

- Developing, maintaining, and monitoring QA policies and procedures
- Providing training to TtNUS staff in QA/QC policies and procedures
- Conducting systems and performance audits to monitor compliance with environmental regulations, contractual requirements, QAPP requirements, and corporate policies and procedures
- Auditing project records
- Monitoring subcontractor quality controls and records
- Assisting in the development of corrective action plans; ensuring correction of nonconformances reported in internal or external audits
- Overseeing the implementation of the QAPP
- Overseeing and reviewing the development and revision of the QAPP
- Overseeing the responsibilities of the TtNUS Site QA/QC Advisor
- Preparing QA reports for management

2.2.3 TtNUS Project QA Advisor

The TtNUS Project QA Advisor provides support to the TOM in preparation and review of the QAPP, coordination of work performed by office technical staff, and performance of data assessment. The Project QA Advisor communicates directly with the QAM on matters of QA/QC.

2.2.4 Laboratory Responsibilities

All samples collected as part of this investigation will be analyzed by Laucks Testing Laboratories, Inc., 940 South Harney Street, Seattle, Washington (206) 767-5060; FAX (206) 767-5063.

The subcontracted laboratory is responsible for analyzing all samples in accordance with the analytical methods and additional requirements specified in this QAPP. It also will be the analytical laboratory's responsibility to properly dispose of unused sample aliquots. Responsibilities of key laboratory personnel are outlined in the following paragraphs.

Laboratory Project Manager

The Laboratory Project Manager will report directly to the TtNUS TOM and will:

- Ensure that method and project-specific requirements are properly communicated and understood by laboratory personnel
- Ensure that all laboratory resources are available on an as-required basis
- Monitor analytical and project QA requirements
- Review data packages for completeness, clarity, and compliance with project requirements
- Inform the TtNUS TOM of project status and any sample receipt or analytical problems

Laboratory Director

Responsibilities of the Laboratory Director include the following:

- Support the QA program within the laboratory
- Provide management overview of both production and quality-related laboratory activities
- Maintain adequate staffing to meet project analytical and quality objectives
- Approve all laboratory Standard Operating Procedures (SOPs) and QA documents
- Supervise in-house chain-of-custody (COC) documentation

- Oversee the preparation of and approve final analytical reports prior to submittal to TtNUS

Laboratory Quality Assurance Officer

The Laboratory QA Officer (QAO) has the overall responsibility for data after it leaves the laboratory. The Laboratory QAO will be independent of the laboratory but will communicate data issues through the Laboratory Project Manager. In addition, the Laboratory QAO will:

- Oversee laboratory QA
- Oversee QA/QC documentation
- Conduct detailed data review
- Determine whether to implement laboratory corrective actions, if required
- Define appropriate laboratory QA procedures
- Prepare laboratory SOPs
- Conduct Internal Audits

Independent QA will be provided by the Laboratory Project Manager and QAO prior to release of all data to TtNUS.

Laboratory Sample Custodian

The Laboratory Sample Custodian will report to the Laboratory Director. Responsibilities of the Laboratory Sample Custodian include the following:

- Receive and inspect the incoming sample containers
- Record the condition of the incoming sample containers
- Sign appropriate documents
- Verify COC
- Notify laboratory manager and laboratory supervisor of sample receipt and inspection
- Assign a unique identification number and customer number, and enter each into the sample receiving log
- With the help of the laboratory manager, initiate transfer of the samples to appropriate lab sections
- Control and monitor access/storage of samples and extracts

Laboratory Technical Staff

The Laboratory Technical Staff will be responsible for sample analysis and identification of corrective actions. The staff will report directly to the Laboratory Director.

2.3 FIELD INVESTIGATION

TtNUS will be responsible for all field activities related to this background investigation. The TtNUS field team will be organized according to the activities planned. Field team members will be selected based on the type and extent of effort required. All team members will be appropriately skilled and trained for the tasks they are assigned to perform. The team will consist of a combination of the following personnel:

- Field Operations Leader (FOL)
- Site QA/QC Advisor
- Site Safety Officer
- Field Technical Staff

2.3.1 Field Operations Leader

The FOL is responsible for coordinating all onsite personnel and for providing technical assistance, when required. The FOL, or designee, will coordinate and lead all sampling activities and will ensure the availability and maintenance of all sampling materials/equipment. The FOL is responsible for the completion of all sampling, field and COC documentation, will assume custody of all samples, and will ensure the proper handling and shipping of samples. The FOL is a highly experienced environmental professional who will report directly to the TtNUS TOM. Specific FOL responsibilities include the following:

- Function as communications link between field staff members, the Site QA/QC Advisor, Site Safety Officer, the NSWC Crane Environmental Site Manager, and the TOM
- Oversee the mobilization and demobilization of all field equipment and subcontractors
- Coordinate and manage the Field Technical Staff
- Adhere to the work schedules provided by the TOM

- Bear responsibility for maintenance of the site logbook, field logbook, and field recordkeeping
- Initiate field task modification requests when necessary
- Identify and resolve problems in the field; resolve difficulties in consultation with the NSWC Crane Site Manager; implement and document corrective action procedures and provide communication between the field team and upper management

2.3.2 Site QA/QC Advisor

The FOL (or his assistant) will act as the Site QA/QC Advisor, who is responsible for ensuring adherence to all QA/QC guidelines as defined in the QAPP. Strict adherence to these procedures is critical to the collection of acceptable and representative data. The following is a summary of the Site QA/QC Advisor's responsibilities:

- Ensure that field duplicates and field QC blanks are collected with the proper frequency
- Ensure that additional volumes of sample are supplied to the analytical laboratory with the proper frequency to accommodate laboratory QA/QC analyses
- Ensure that measuring and test equipment are calibrated, used, and maintained in accordance with applicable procedures
- Act as liaison between site personnel, laboratory personnel, and the QAM
- Manage bottleware shipments and oversee field preservation

2.3.3 Site Safety Officer

The FOL (or designee) will also serve as the SSO. The duties of the SSO are detailed in the HASP. The SSO has stop-work authority, which can be executed upon the determination of an imminent safety hazard.

2.3.4 Field Technical Staff

The Field Technical Staff for this project will be drawn from TtNUS's pool of qualified personnel. All of the designated field team members will be experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

Field staff are responsible for complying with field-related requirements as presented in the QAPP.

2.4 SPECIAL TRAINING REQUIREMENTS AND CERTIFICATIONS

All field personnel will have appropriate training to conduct the field activities to which they are assigned. Additionally, each site worker will be required to have completed a 40-hour course in Health and Safety Training as described under OSHA 29 CFR 1910.120(b)(4).

Laucks Testing Laboratories, Inc. has successfully completed the laboratory evaluation process required as part of the NFESC QA Program and described in the "Navy Installation Restoration Laboratory Quality Assurance Guide" (NFESC, 1996).

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TABLE 2-1

**NAMES, PHONE NUMBERS AND ADDRESSES
NSWC CRANE, CRANE, INDIANA
PAGE 1 OF 2**

PERSON / TITLE / ORGANIZATION	ADDRESS	TELEPHONE
Peter Ramanauskas Project Manager U.S. EPA Region 5	EPA Region 5 77 West Jackson Street Chicago, Illinois 60604	(312) 886-7890 FAX: (312) 353-4788
Allen Debus QA Coordinator U.S. EPA Region 5	EPA Region 5 77 West Jackson Street Chicago, IL 60604	(312) 886-6186
Marty Harmless Office of Solid and Hazardous Waste Management IDEM	Office of Solid and Hazardous Waste Management 100 N. Senate Avenue Indianapolis, Indiana 46206-6015	(317) 234-0597
Doug Griffin Corrective Action Section Office of Land Quality Hazardous Waste Permits IDEM	Corrective Action Section Office of Land Quality Hazardous Waste Permits 100 N. Senate Avenue P. O. Box 6015 Indianapolis, IN 46206-6015	(317) 233-2710
Bill Gates Remedial Project Manager U.S. Navy SOUTHNAVFACENGCOM	Department of Navy SOUTHNAVFACENGCOM Code 1829 2155 Eagle Drive Charleston, SC 29406	(843) 820-7360 FAX: (843) 820-7465
Tom Brent Environmental Site Manager NSWC Crane	NSWC Crane Code 095 B-3260 300 Highway 361 Crane, Indiana 47522-5009	(812) 854-6160 FAX: (812) 854-4177
Debbie Wroblewski Program Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8968 FAX: (412) 921-4040
Paul Frank Quality Assurance Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8950 FAX: (412) 921-4040
Matt Soltis Health and Safety Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8912 FAX: (412) 921-4040
Roger Clark Task Order Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8415 FAX: (412) 921-4040
Keith Simpson Field Operations Leader Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-7090 FAX: (412) 921-4040

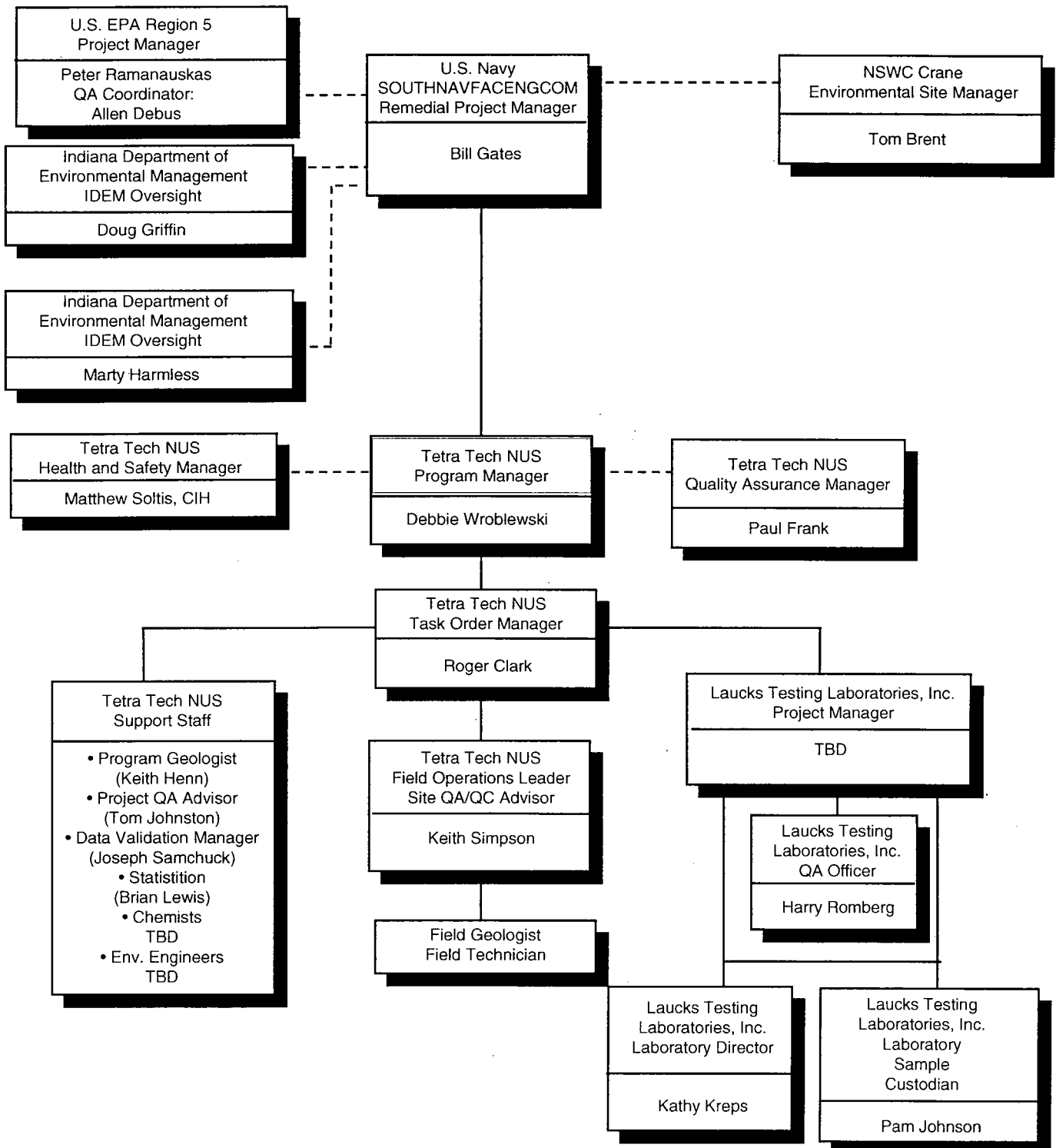
TABLE 2-1

**NAMES, PHONE NUMBERS AND ADDRESSES
NSWC CRANE, CRANE, INDIANA
PAGE 2 OF 2**

PERSON / TITLE / ORGANIZATION	ADDRESS	TELEPHONE
Keith Henn Program Geologist Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8146 FAX: (412) 921-4040
Tom Johnston Project QA Advisor Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8615 FAX: (412) 921-4040
Joseph Samchuck Data Validation Manager Tetra Tech NUS	Tetra Tech NUS 661 Anderson Drive Pittsburgh, PA 15220	(412) 921-8510 FAX: (412) 921-4040
Brian Lewis Statistician Tetra Tech NUS	Tetra Tech NUS 661 Anderson Drive Pittsburgh, PA 15220	(412) 921-7105 FAX: (412) 921-4040
TBD Project Manager Laucks Testing Laboratories, Inc.	Laucks Testing Laboratory 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5063
Harry Romberg Lab QA Officer Laucks Testing Laboratories, Inc.	Laucks Testing Laboratory 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5063
Kathy Krepps Lab Director Laucks Testing Laboratories, Inc.	Laucks Testing Laboratory 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5063
Pam Johnson Lab Sample Custodian Laucks Testing Laboratories, Inc.	Laucks Testing Laboratory 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5063

FIGURE 2-1

**PROJECT ORGANIZATION CHART
NAVAL SURFACE WARFARE CENTER
NSWC CRANE, CRANE, INDIANA**



3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective for this project is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, data management and reporting that will yield results sufficient to support the attainment of the project objectives specified in Section 1.0. Intended data uses, including the list of project target parameters, are described in Section 1.4 of this QAPP. How decision-making will be based on data comparisons is described in Section 12.4. Specific procedures for sampling, chain-of-custody, laboratory instrument calibration, laboratory analysis, internal QC, reporting of data, audits, preventive maintenance of field and laboratory equipment, data management, corrective action, and reporting to management are described in the remaining sections of this QAPP. As part of those evaluations, statistical parameters such as data set variances will be computed that provide direct insight into the variability of target analyte data in soils. Overall QC level of effort is described in Section 3.6.

The PARCC parameters (precision, accuracy, representativeness, comparability, and completeness) are qualitative and quantitative statements regarding the quality characteristics of the data used to support project objectives and ultimately, environmental decisions. These parameters are presented in the remainder of this section. QC samples used to evaluate performance and their frequencies of use are described in Section 8.1 (field QC samples), and Section 8.2 (laboratory QC samples). Equations used to compute accuracy, precision, and completeness values are provided in Sections 12.1 through 12.3.

3.1 PRECISION

3.1.1 Definition

Precision is a measure of the degree to which two or more measurements are in agreement and describes the reproducibility of measurements of the same parameter for samples analyzed under similar conditions. A fundamental tenet of using precision measurements for QC is that precision will be bounded by known limits. Results outside these predetermined limits trigger corrective actions.

Because of the inherent and unknown heterogeneity of soil samples, the precision of soil field duplicate samples will not be used for QC, but will be compared to laboratory precision estimates to gain a perspective on the natural heterogeneity of the soil.

3.1.2 Field Precision Objectives

Field precision is assessed by collecting and measuring field duplicates at a rate of 1 duplicate per 10 environmental samples. Acceptance limits for field duplicate precision are provided in Table 3-1. This precision estimate encompasses the combined uncertainty associated with sample collection, homogenization, splitting, handling, laboratory and field storage, digestion, and analysis. In contrast, precision estimates obtained from analyzing duplicate laboratory samples incorporate only homogenization, subsampling, digestion, laboratory storage, and analysis uncertainties. Consequently, the field precision estimates [i.e., relative percent difference (RPD) values] should equal or exceed the laboratory precision estimates, on average, for each analyte. If field duplicate precision is significantly different from laboratory duplicate precision, the underlying cause will be investigated to determine whether the observed difference could be artifacts of sampling and analysis. Considerations given to this effort include:

- The scale of subsampling for laboratory precision estimates relative to the scale of field duplicate sample size.
- Analytical measurement precision.
- Precision for repeat analysis of the same solid laboratory control sample (LCS).
- Estimated environmental sample grain size relative to LCS grain size.
- Potential natural soil heterogeneity

3.1.3 Laboratory Precision Objectives

Laboratory precision QC samples [i.e., laboratory duplicates for inorganic chemicals and matrix spike duplicates (MSDs) for organic chemicals] will be analyzed with a minimum frequency of 5 percent (i.e., 1 QC sample per 20 environmental samples). Laboratory precision is measured by comparing RPD values with precision control limits specified in Table 3-1.

3.2 ACCURACY

3.2.1 Definition

Accuracy is the degree of agreement between an observed value and an accepted reference value. This parameter is assessed by measuring spiked samples [e.g., surrogate spikes or matrix spikes (MSs)] or well-characterized samples of certified analyte concentrations (e.g., LCSs) and by measuring blanks. Accuracy measurements are designed to detect biases resulting from the sample handling and analysis processes. The equations for determining accuracy of an individual MS and a surrogate spike or LCS for

this project are provided in Section 12.1. The equations in Section 12.1 do not apply to blank samples, however, because division by zero (the expected amount or added amount) causes the calculated value to be infinite. Instead, acceptance criteria are designed to limit the tolerable amount of contamination while recognizing that non-zero results for blanks are likely, if only because of random error in the measurement process. The Laucks Testing Laboratories, Inc. analytical SOPs limit tolerable blank concentrations. The bias computations for individual MSs, LCSs and method blanks will be used to control the analysis process by triggering corrective actions as specified in Table 3-2.

3.2.2 Field Accuracy Objectives

Accuracy requirements for field measurements are typically ensured through control over the sample collection and handling and through routine instrument calibration. Accuracy of grain size and depositional environment classifications is ensured by requiring that a qualified field geologist makes those classifications.

Accuracy is also typically monitored through the use of blanks to detect cross-contamination and by monitoring adherence to procedures that prevent sample contamination or degradation. Equipment rinsate blanks shall be collected for this investigation to assess cross-contamination via sample collection equipment. Ambient condition blanks will not be collected unless site conditions during sampling (e.g., generation of fugitive dust) indicate a need to assess infiltration of airborne contaminants into sampling containers. Source water blanks will be collected to monitor the purity of water used to decontaminate sampling equipment. Accuracy shall also be assured qualitatively through adherence to all sample handling, preservation, and holding time requirements.

3.2.3 Laboratory Accuracy Objectives

Accuracy in the laboratory is measured through the comparison of a spiked sample or LCS result to a known or calculated value and is expressed as a percent recovery (%R). It is also assessed by monitoring the analytical recovery of select surrogate compounds added to samples that are analyzed by organic chromatographic methods. MS and surrogate compound analyses measure the combined accuracy effects of the sample matrix, sample preparation and sample measurement. LCSs are used to assess the accuracy of laboratory operations with minimal sample matrix effects. Post-digestion spikes (PDSs) are used to assess the accuracy of the analytical measurement on the sample extract or digestate. Each spiked sample shall be spiked with all project target analytes for the analysis being performed to ensure that accuracy measures are obtained for each target analyte. Spiking concentrations shall equal or approximate the default concentrations detailed in the applicable sample

preparation SOPs. LCS and MS analyses are performed at a frequency no less than 1 per 20 associated samples of like matrix. Laboratory accuracy is assessed via comparison of calculated %R values to accuracy control limits specified in Tables 3-1 and 3-3.

3.3 COMPLETENESS

3.3.1 Definition

Completeness is a measure of the amount of usable, valid analytical data obtained compared to the amount expected to be obtained. Completeness is expressed as a percentage.

3.3.2 Field Completeness Objectives

Field completeness is a measure of the amount of valid field measurements obtained from all the field measurements taken in the project. Documentation of sample location and depth is planned for each soil sample. Documentation of grain size and depositional environment is also planned for each soil sample. A completeness criterion of 100% applies to these measurements. However, the 100% completeness criterion for depositional environment and grain size may be reduced, depending on whether these factors are significant for background comparisons, as determined under the "Base-wide Background Soil Investigation for NSWC Crane." Furthermore, failure to document grain size and depositional environment may be recoverable by inspecting field logs and site maps, or through laboratory measurement once the samples are received by the laboratory. Failure to obtain 100% of these measurements for field samples will indicate a need for corrective actions designed to recover the missing information. Failure to recover the information will constitute a need to resample, unless the missing data are judged not to adversely affect attainment of project objectives.

3.3.3 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of usable, valid laboratory measurements per matrix obtained for each of the target analytes. Usable, valid results are those that are judged, after data assessment, to represent the sampling populations and to have not been disqualified for use through data validation or data assessment.

Laboratory completeness objectives are 75% for each critical target analyte per sample matrix (soil). The use of kriging (i.e., geostatistical contouring), which can interpolate missing values may mitigate some of the adverse effects experienced from loss of data. Furthermore, the impact of missing soil data cannot be quantified in advance of sampling because the impact will depend on which data are missing. The

impact of the loss of any other particular datum on attainment of project objectives will be evaluated during data assessment.

Qualifications on the use of data caused by incomplete data sets will be documented in the Soils RFI report.

3.4 REPRESENTATIVENESS

3.4.1 Definition

Representativeness is an expression of the degree to which the data accurately and precisely represent a characteristic of a population or environmental condition existing at the site. Adherence to the SAP (Section 4) and use of standardized sampling, handling, preparation, analysis, and reporting procedures ensures that the final data accurately represent the desired populations. An assessment of representativeness will be made during data assessment to determine whether each datum belongs to the observed data distribution through outlier testing. The statistical tests to be used are described in Section 12.4. Any anomalies will be investigated to assess their impact on statistical computations.

3.4.2 Measures to Ensure Representativeness of Field Data

Representativeness depends upon the proper design of the sampling program and will be satisfied by ensuring that the SAP (Section 4) is followed and that proper sampling techniques are used. Strict adherence to soil type descriptions and care to ensure that a soil sample representing the appropriate depth interval is placed into each sample container will be ensured during sample collection.

3.4.3 Measures to Ensure Representativeness of Lab Data

Representativeness in the laboratory is ensured or evaluated by using the proper analytical procedures, meeting sample holding times, and analyzing and evaluating field duplicate samples relative to laboratory duplicates. During development of this QAPP, measures to ensure representativeness of the data generated included consideration of past operations, aerial photographs, existing analytical data, physical setting, depositional environments, spatial coverage of the proposed sampling locations, accessibility to sampling locations, and constraints inherent to the RCRA program. The rationale of the sampling network is presented in detail in Section 4.

3.5 COMPARABILITY

3.5.1 Definition

Comparability is defined as the confidence with which one data set can be compared to another (e.g., between sampling points; between sampling events). Comparability is achieved by using standardized sampling and analysis methods and data reporting formats (including use of consistent units of measure), and by ensuring that reporting and detection limits are sufficiently low to satisfy project detection and quantitation criteria for the duration of the project. The RLs anticipated for this project are presented in Table 1-7. Additionally, consideration was given to seasonal conditions and other environmental variations that could exist to influence analytical results, but no such influences appear to exist for this investigation that would indicate a need to collect samples at times other than those planned for this investigation.

3.5.2 Measures to Ensure Comparability of Field Data

Comparability depends upon the proper design of the sampling program and will be satisfied by ensuring that Section 4 of this QAPP is followed and that proper sampling techniques are used. The rationale behind the SAP design is found in Section 4.

3.5.3 Measures to Ensure Comparability of Laboratory Data

Planned analytical data will be comparable when similar sampling and analytical methods are used and documented. The use of sampling and analysis methods in this investigation that are comparable in performance to those used in the "Base-Wide Background Soil Investigation for NSWC Crane" should limit the need to consider biases when making soil data set comparisons for metals. Results will be reported in units that ensure comparability with previous data. The units used for the laboratory measurements are further explained in Section 9.1.2 of this QAPP.

3.6 LEVEL OF QUALITY CONTROL EFFORT

Several QC samples will be analyzed for this project to provide a means to assess field and laboratory performance. Field QC samples consist of field duplicates, equipment rinsate blanks, source water blanks, temperature blanks, and, at the discretion of the FOL, ambient condition blanks. These QC checks are described in Section 8.1. Each type of field QC sample undergoes the same preservation, analysis, and reporting procedures as the related environmental samples. Frequencies of field QC

sample collection and analysis are presented in Table 3-2. The types and numbers of QC samples to be collected in the field are presented in Table 4-2.

Laboratory QC encompasses a host of other checks performed during sample preparation and analysis, as described in Section 8.2. Frequencies for laboratory QC checks are provided in Table 3-2 and in the method-specific laboratory SOPs appended to this QAPP (Appendix C).

TABLE 3-1
QUALITY CONTROL LIMITS
FIELD DUPLICATES, LABORATORY DUPLICATES, MATRIX SPIKES,
MATRIX SPIKE DUPLICATES AND SURROGATES
NSWC CRANE, CRANE, INDIANA

Chemical (Analysis Method)	Soil	
	Accuracy (%R) ⁽¹⁾	Precision (RPD) ^(2,3)
METALS (SW-846 METHOD 6010B OR 6020, AS INDICATED)		
Arsenic (SW-846 Method 6020)	75% - 125%	≤50%
Beryllium (SW-846 Method 6020)	75% - 125%	≤50%
Manganese (SW-846 Method 6010B)	75% - 125%	≤50%
ENERGETICS (SW-846 METHOD 8330)		
2,4,6-Trinitrotoluene	65% - 140%	≤50%
2,6-Dinitrotoluene	65% - 140%	≤50%
RDX	65% - 145%	≤50%
1,2-Dinitrobenzene (surrogate)	60% - 140%	NA
POLYCYCLIC AROMATIC HYDROCARBONS (SW-846 METHOD 8270C, WITH SELECTIVE ION MONITORING)		
Benzo(a)anthracene	20% - 160%	≤30%
Benzo(a)pyrene	20% - 160%	≤30%
Benzo(b)fluoranthene	20% - 160%	≤30%
Dibenzo(a,h)anthracene	20% - 160%	≤30%
Indeno(1,2,3-c d)pyrene	20% - 160%	≤30%
1-Fluoronaphthalene (surrogate)	20% - 160%	NA
Fluorene-d10 (surrogate)	20% - 160%	NA
Pyrene-d10 (surrogate)	20% - 160%	NA
PESTICIDES (SW-846 METHOD 8081A)		
Heptachlor Epoxide	40% - 145%	≤50%
Decachlorobiphenyl (surrogate)	20% - 160%	NA
Tetrachloro-m-xylene (surrogate)	20% - 150%	NA

%R = Percent Recovery

RPD = Relative Percent Difference

- 1 These acceptance limits apply to spikes that augment the native sample analyte concentration by at least 25%.
- 2 These acceptance limits apply to original and duplicate sample concentrations >5X RL. If one of the results is <5X RL, the acceptance criterion is ±RL. If one or the other results is a non-detect, the reported %RPD will be 200%.
- 3 These limits apply to both field and laboratory duplicate samples.

TABLE 3-2

**NON-CALIBRATION QC SAMPLE USAGE FREQUENCIES,
ACCEPTANCE LIMITS AND CORRECTIVE ACTIONS
NSWC CRANE, CRANE, INDIANA
PAGE 1 OF 2**

QC Sample Type	Collection Frequency	Acceptance Limits	Corrective Action
Field Duplicate	1 per 10 investigative samples collected.	See Table 3-1	Qualify data according to data validation requirements.
Equipment Rinsate Blank	1 per 10 investigative samples collected, with a minimum of one per day of sampling, per non-disposable sampling device/instrument. For pre-cleaned, dedicated, and/or disposable equipment (i.e., disposable plastic trowels, etc.), one rinsate blank will be collected and analyzed at a frequency of one per lot or "batch blank" for a specific equipment type.	< RL	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Source Water Blank	1 per each source of water used for sampling equipment decontamination.	< RL	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Ambient Condition Blanks	At discretion of FOL	< RL	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Internal Standard	At least one internal standard per sample for GC/MS analyses.	Retention times stable to ± 30 seconds; area counts stable to within factor of 2.	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 12.4.
Laboratory Control Sample	1 per 20 environmental samples per matrix	See Table 3-3	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 12.4.
Laboratory Duplicate	1 per 20 environmental samples analyzed for inorganic target analytes	See Table 3-1	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 12.4.
Laboratory Method Blank	1 per 20 environmental samples or per preparation batch, whichever is more frequent	< RL	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 12.4.

TABLE 3-2

**NON-CALIBRATION QC SAMPLE USAGE FREQUENCIES,
ACCEPTANCE LIMITS AND CORRECTIVE ACTIONS
NSWC CRANE, CRANE, INDIANA
PAGE 2 OF 2**

QC Sample Type	Collection Frequency	Acceptance Limits	Corrective Action
Matrix Spike*	1 per 20 environmental samples	See Table 3-1	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 12.4.
Matrix Spike Duplicate*	1 per 20 environmental samples analyzed for organic target analytes	See Table 3-1	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 12.4.
Post-digestion Spike	Only if out-of-control matrix spike exists (metals only)	100 \pm 20%	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 12.4.
Surrogate	At least one per sample for organic chromatographic analyses (GC, GC/MS, and HPLC)	See Table 3-1	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 12.4.
Temperature Blank	One blank per sample cooler.	4 \pm 2 °C	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 12.4.

- * Matrix spikes and matrix spike duplicates are not analyzed in the field, but additional sample material must be collected in the field to ensure that the laboratory has enough material for spiking and duplicate analysis. See Table 4-3 for details regarding extra volume required.

TABLE 3-3
QUALITY CONTROL LIMITS
LABORATORY CONTROL SAMPLES
NSWC CRANE, CRANE, INDIANA

Chemical	Soil Accuracy (%R)
METALS (SW-846 METHOD 6010B OR 6020, AS INDICATED)	
Arsenic (SW-846 Method 6020)	80% - 120%
Beryllium (SW-846 Method 6020)	80% - 120%
Manganese (SW-846 Method 6010B)	80% - 120%
ENERGETICS (SW-846 METHOD 8330)	
2,4,6-Trinitrotoluene	65% - 140%
2,6-Dinitrotoluene	65% - 140%
RDX	65% - 145%
POLYCYCLIC AROMATIC HYDROCARBONS (SW-846 METHOD 8270C, WITH SELECTIVE ION MONITORING)	
Benzo(a)anthracene	20% - 160%
Benzo(a)pyrene	20% - 160%
Benzo(b)fluoranthene	20% - 160%
Dibenzo(a)pyrene	20% - 160%
Indeno(1,2,3-cd)pyrene	20% - 160%
PESTICIDES (METHOD SW-846 8081A)	
Heptachlor Epoxide	20% - 160%

%R = Percent Recovery

4.0 SAMPLING AND ANALYSIS PLAN DESIGN AND RATIONALE

This section contains the SAP for the ORR. It includes a description of the applicable environmental sampling networks as well as the strategies and rationales behind the sampling plan designs. The mechanics of sample collection, packaging, shipping and documentation are also described either explicitly or through citation of SOPs contained in Appendix B.

Surface and subsurface soils will be collected at the ORR and OPR (SWMU 7).

Analysis of Variance (ANOVA) and kriging of data generated under this investigation will be conducted by statisticians/geostatisticians experienced in the use of those techniques. Their input will be solicited when interpreting the data. Kriging was used to establish plausible initial estimates of contamination boundaries for determining where the initial round of ORR proper soil samples should be placed.

In the discussions following, all references to soil background concentrations for metals refer to the mean background concentrations to be determined under the "Base-wide Background Soil Investigation for NSWC Crane" which is currently in progress. Background soil comparisons will consider the soil sample depositional area, grain size and depth.

Site-specific health and safety concerns and processes used to govern the protection of worker health and safety are described in the HASP (Appendix D).

4.1 SAMPLING DESIGN AND RATIONALE

This section contains the rationale for soil sampling at the ORR and OPR. It summarizes the proposed sampling locations, sampling procedures, planned analyses, and the field operations that are to be followed as part of sample acquisition. Specific details regarding soil sampling and analysis and field operations are provided in later subsections of this SAP. Target parameters are listed in Table 1-6. Laboratory methods are listed in Section 7.

4.1.1 Old Rifle Range

Results of the CCCRA indicated that data gaps exist for soils at the ORR with respect to the berms used as projectile backstops. To fill these data gaps, soil samples will be collected from the front berms of the backstops and along the hillside of the southern-most shooting range. Samples will be collected from the surface and subsurface soils at each location. The sampling will provide data on certain contaminants

that may have been introduced into the berms by projectiles being fired into them. Metals are not likely to have moved significantly, even under the influence of rainfall. However, some erosion potential exists, and the eroding soils could have carried contaminants down gradient. Furthermore, organic chemicals are likely to be more mobile than the metals. The sample collection scheme is designed to bound contamination at the ORR both horizontally and vertically.

The initial sampling geometry will be based on a parameterless krig of past COC analysis results. A parameterless (non-COC specific) krig essentially normalizes and overlays the kriged COC concentrations to establish the boundary within which any COC concentration exceeds its bounding criterion. In this case, the bounding criterion for each COC is a concentration that is greater than RBTL AND greater than the background action level concentration.

The geostatistical kriging presented in Figures 4-1 and 4-2 was conducted using Ctech's Environmental Visualization System (EVS) software, version 3.60. The depths for the data points on Figure 4-1 are surface soils (0-2'). The proposed depths for the data points on Figure 4-2 are surface soils, which will be collected at 0-1' for consistency with the Background Study. For each historical sample location (Figure 4-1), ratios of the maximum detections compared to the RBTL were calculated for each of the COCs detected. The kriging process uses the maximum ratio calculated for each sample location. In both of these figures, the shaded area represents the minimum contaminated area expected at a 99% confidence level. The solid and dashed lines define the minimum contaminated area expected at a 90% confidence level. Both confidence levels were shown to ensure the most effective location of the proposed sample locations shown in Figure 4-2. Arsenic results were included for kriging, even though they may be excluded following comparison to background concentrations. Because arsenic was included, the kriging outline is considered to be conservative. Additional ORR soil sampling locations are discussed in the following paragraph or Section 4.1.2.

The berm area within the western boundary of the ORR is also of interest for this investigation because it is a localized area in which chemicals could have been released as part of site operations. For purposes of distinguishing between the sample locations, the berms are identified as Berms 1, 2, and 3, from north to south respectively. Figure 4-3 shows proposed sampling locations for the ORR berms.

Multiple sampling and analysis rounds may be required to establish the requisite COC contamination perimeter, as described in the decision rule in Section 1.4.2.2. However, sampling beyond two rounds and sampling beyond the initial ORR kriged boundary will not occur without prior discussion among the U.S. EPA, the IDEM, the U.S. Navy, and TtNUS. If multiple sampling rounds are required, it is expected

that the sampling in round $n+1$ will extend outward relative to the sampling conducted under round n , where n indicates the sequential round number.

4.1.2 Old Pistol Range

According to Base personnel, the OPR was not recognized as having a history of firing range operations and therefore no environmental samples have ever been collected there. During a site reconnaissance conducted by Base personnel and TtNUS, potential areas were identified for collection of soil samples. These areas include soils at the pistol range backstop, the hillside to the west of the pistol firing line, and soils close to the 55-gallon drums used for storing spent cartridges. Figures 1-5 and 4-4 show OPR site features.

Composite samples will be collected at the OPR to minimize the number of samples required for covering this relatively large area. Composite samples will be formed by mixing equal volumes of soil from each of three aliquots collected within a given sampling depth interval. The sampling locations of the aliquots to be mixed when compositing are bounded in Figure 4-4 by dashed lines, with each rectangular box indicating a set of three aliquots to be composited. Samples from depth intervals of 0 to 1 feet bgs and 2 to 4 feet bgs will be composited from each of the locations depicted. Sample compositing is governed by SOP CTO 56-1. From the composite samples results, concentration gradients will be used to indicate whether COC contamination has been adequately bounded. Figure 4-4 also shows grab soil sampling locations at 2 depths. These samples will be collected on the hillside (Range 1) and the berm (Range 2).

The strategy behind the sampling scheme is similar to that for the ORR proper – to establish a three-dimensional perimeter within which COC concentrations exceed RBTLs and background action level concentration, and outside of which COC concentrations are less than RBTLs or background action level concentrations.

Multiple sampling and analysis rounds may be required to establish the requisite COC contamination perimeter, as described in the decision rule in Section 1.4.2.2. However, sampling beyond two rounds and sampling beyond the OPR boundary will not occur without prior discussion among the U.S. EPA, the IDEM, the U.S. Navy, and TtNUS. If multiple sampling rounds are required, it is expected that the sampling in round $n+1$ will extend outward relative to the sampling conducted under round n , where n indicates the sequential round number.

4.2 FIELD MOBILIZATION / DEMOBILIZATION

Following approval of the QAPP, TtNUS will begin mobilization activities. All field team members will review the QAPP (including the HASP, Appendix D) prior to mobilization. In addition, a field team orientation meeting will be held to familiarize personnel with the scope of the field activities. Items to be presented during that meeting include:

- Identification of the QAPP, including the HASP and applicable field SOPs (Appendix B)
- Site-specific safety concerns and requirements
- Project objectives
- Sampling designs and strategies for soil and ground water (including the relationship of soils data for this project to NSWC Crane background soil data)
- Site-specific particulars of field operations (e.g., locations of utilities, physical access to sampling location, communication mechanisms, lines of authority and responsibility, scheduling requirements, sample shipping concerns, etc.)

The FOL will coordinate the mobilization activities for this project. The equipment required for the field activities will be mobilized from TtNUS's Pittsburgh office and/or the field office facilities at NSWC Crane by the FOL and the field crew. The ORR/OPR is in a fairly remote area of the Base. As a result, electricity is not available on-site. Therefore, electric-powered equipment, if required, will be supplied from portable gas-powered generators. It is presently anticipated that no portable gas-powered equipment will be used during field operations, but if conditions arise that require such equipment, an application for their use will be made to the NSWC Crane Fire Department. The FOL and crew will demobilize from the site upon completion of the field operations and transport field equipment back to the Pittsburgh office, as necessary.

4.3 SOIL SAMPLE COLLECTION AT THE ORR AND OPR

This section describes the specifics concerning proposed sampling locations, sampling procedure, planned analyses and field operations which are to be followed as part of soil sample acquisition. Target analytes are listed in Table 1-6. Field investigation soil sampling summaries for the ORR/OPR are shown on Table 4-1. The chemical analysis summary, including the numbers of soil samples to be collected, is

shown in Table 4-2. The summary of sample analyses, bottle requirements, preservation requirements, and holding time requirements is listed in Table 4-3.

4.3.1 Surface Soil Sampling

Before samples are collected, all pertinent ambient conditions and field data will be recorded in the field logbook and on the soil sample log sheet (examples included in SOP CTO 56-4, Appendix B).

At the OPR and ORR, surface soil samples will be collected from the ground surface to a depth of 1 foot (i.e., 0 to 1 foot) during advancement of soil borings using a stainless-steel hand auger or Direct Push Technology (DPT), depending on site conditions. The hand auger consists of a stainless steel auger bucket and steel rods (each typically 3 feet in length). Commonly referred to as an Iwan sampler, the auger is advanced by turning a "T" handle in a clockwise motion. Samples will be extracted from the auger bucket using a disposable polyethylene (or stainless steel) trowel and a stainless-steel mixing bowl. SOP CTO 56-1 in Appendix B provides additional information on borehole advancement and sample collection using a hand auger.

Upon retrieval, all samples obtained will be monitored for volatile organic compounds (VOCs) with a photoionization detector (PID) for health and safety concerns as described in Section 4.3.4 and then examined for visual lithologic classification. The 0- to 1-foot depth interval will be placed into appropriate sample bottles as listed in Table 4-3. Table 4-1 identifies the sampling depth of soil samples for chemical analysis. All samples will be placed in a cooler of ice immediately after collection. SOP CTO 56-2 provides additional information for handling soil samples. Soil sampling will continue to depths beyond the surface interval as described in the Section 4.3.2.

4.3.2 Subsurface Soil Sampling

Before samples are taken, all pertinent ambient conditions and field data are recorded in the field logbook and on the soil sample log sheet (examples included in SOP CTO 56-4, Appendix B). All subsurface samples shall be collected from the same soil boring as the corresponding surface sample.

At the OPR and ORR, subsurface soil samples will be collected over the depth interval of 2 feet to 4 feet bgs using a stainless-steel hand auger or DPT depending on site conditions, as described in Section 4.3.1.

Upon retrieval, all samples will be monitored for VOCs with a PID for health and safety concerns and then examined for visual classification of the lithology. Sample intervals are detailed in Table 4-1. All samples will be placed in a cooler of ice immediately after collection. SOP CTO 56-2 provides additional information on handling of soil samples.

After sampling, the boreholes will be abandoned by backfilling the hole with remaining soil cuttings.

Waste soil will be handled in accordance with Section 4.10.

4.3.3 Borehole and Soil Sample Logging

A lithologic description of each soil sample and a complete log of each boring will be maintained by the TtNUS geologist in accordance with SOP CTO 56-4 (Appendix B). At a minimum, the boring log will contain the following information:

- Boring identification
- Name of geologist logging the boring
- Sample numbers and types
- Sample depths
- Soil density or cohesiveness
- Soil color
- Unified Soil Classification System (USCS) material description
- Location of boring
- Augering or DPT problems/deviations from project-specific SAP

In addition, depths of changes in lithology, sample moisture observations, depth to water, organic vapor (i.e., PID) readings, augering methods, and total depth of each borehole will be included on each log, as well as any other pertinent observations. An example of the boring log form is included in SOP CTO 56-4 (Appendix B).

4.3.4 Field Measurements for Soil Sampling

All soil samples will be screened for VOCs for health and safety purposes. The site HASP (Appendix D) governs the calibration and use of the organic vapor monitoring instruments (i.e., PID).

Soil samples will be classified according to depositional environment and grain size (clay, silt or sand). These classifications will be comparable to those used in the "Base-wide Background Soil Investigation for NSWC Crane" so as to permit accurate comparisons when determining whether site target analyte concentrations exceed background concentrations.

Soil samples will also be characterized with regard to horizontal mapping coordinates and the depth of the sampling interval.

4.4 SAMPLE IDENTIFICATION SYSTEM

All samples will be properly labeled with a sample label affixed on the sample container and a sample tag secured around the neck of the sample container. The sample labels and sample tags will include the following information: project name, sample tracking number, sampling date, laboratory analyses requested, matrix type, and preservative.

Each sample collected will be assigned a unique sample tracking number or identification as per SOP CTO 56-6 (Appendix B). The sample tracking number is a multi-segment, alpha-numeric code that identifies the site, type of sample, and sample location. Any other pertinent information regarding sample identification will be recorded in the field logbooks and/or sample logsheets. Examples of the sample tracking numbers to be used for this project are provided in Tables 4-1.

MS and laboratory duplicate samples will be designated on the field documentation forms and sample labels.

4.5 SAMPLE HANDLING, PRESERVATION AND SHIPPING

Sample handling includes the field-related considerations connected with selecting sample containers, preservatives, allowable holding times, and analyses requested. Samples may be unstable and therefore require preservation to prevent changes in either the concentration or the physical condition of the constituent(s) requiring analysis. Preservation requirements for each of the chemicals of interest are provided in Table 4-3.

The following procedures will be followed when shipping samples for laboratory analysis:

- All samples will be promptly chilled with ice to $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and packaged in an insulated cooler for transport. Each cooler shipped to the laboratory will include a temperature blank. Ice will be sealed

in containers to prevent water leakage. Samples will not be frozen. Each sample container will be placed in a zip-lock bag to prevent contamination. The zip-lock bag will be placed in a bubble-wrap sleeve to protect from breakage. The temperature of the cooler will be measured using the temperature blank and then recorded in the appropriate section of the COC form.

- Only shipping containers that meet all applicable state and federal standards for safe shipment will be used.
- Shipping containers will be sealed with nylon strapping tape in at least two places, and custody seals will be signed, dated, and affixed in a manner that will allow the receiver to quickly identify any tampering that may have occurred during transport to the laboratory.
- The field COC document will be taped to the top inside cover of the shipping container in a sealed plastic envelope.
- Shipment will be made by a public courier at the next scheduled pickup following completion of sample collection.

SOP CTO 56-2 (Appendix B) provides detailed descriptions of soil sample handling, packaging, and shipping procedures required for this project. The FOL will be responsible for ensuring the completion of the following forms:

- Sample Labels
- COC Forms
- Custody Seals for Coolers
- Shipping Labels for Coolers
- Express Mail Air Bills

4.6 SAMPLE CUSTODY

Custody of samples must be maintained and documented at all times as per SOP CTO 56-4 beginning with the collection of samples in the field. Sample custody procedures are addressed in Section 5.

4.7 QUALITY CONTROL SAMPLES

This section focuses on field QC samples that will be collected as part of this environmental investigation. Field QC samples include field duplicates, source water blanks, equipment rinsate blanks, and ambient blanks. Table 4-2 presents the types and numbers of required field QC samples. Section 8.1 provides definitions and details for these, and all other quality control checks to be used during this investigation. Field QC sample requirements for field duplicates, source water blanks, equipment rinsate blanks, and ambient blanks required for this project are as follows:

Field Duplicates. The field duplicate QC sample requirement for this project will be met as follows:

Soil duplicates will be collected at the ORR/OPR. Field duplicates are obtained during a single act of sampling and are used to assess the overall precision of the sampling and analysis program. Ten percent of all soil samples are required. All samples will be analyzed for the same parameters in the laboratory as their environmental sample counterparts.

Equipment Rinsate Blanks. Equipment rinsate blanks will be obtained under representative field conditions by running analyte-free water through sample collection equipment after decontamination and placing it in the appropriate sample containers for analysis. Equipment rinsate blanks will be collected for non-dedicated equipment for all sampling rounds. Decontamination procedures for non-dedicated equipment will be conducted and are provided in SOP CTO 56-5 (Appendix B).

Source Water Blanks. Source water blanks will be obtained by sampling the waters used for decontaminating sampling equipment during the field investigation. Source water blanks will be used to determine if the analyte-free water or the laboratory bottles are contributing to sample contamination. Source water blanks will be collected for each type of water used for decontamination and will be submitted at a frequency of one per sampling event. Source water blanks, as applicable, will be analyzed for the entire suite of parameters under investigation. It is anticipated that one source water blank will be collected for each sampling round.

Ambient Blanks. Ambient blank samples will be obtained at the discretion of the FOL if the FOL believes that infiltration of airborne contaminants into field samples is a possibility. Ambient condition blanks are samples of deionized water poured from one container to another in the field to detect this type of airborne contaminant infiltration into field samples.

4.8 SURVEYING

The horizontal location of all soil samples will be surveyed. A global positioning system (GPS) or other suitable surveying device will be used to identify horizontal locations of each of the samples collected. The horizontal location will be surveyed to the Indiana State Plane Coordinates within the nearest foot and referenced to the 1983 North American Datum (NAD83). Identification of the vertical locations of the samples will not be performed.

4.9 INVESTIGATION DERIVED WASTE

It is anticipated that this investigation will generate three types of potentially contaminated residues or investigation derived waste (IDW):

- Personal protective equipment (PPE)
- Equipment decontamination fluids
- Waste soils from soil borings

IDW will be handled as follows:

PPE - All PPE will be double bagged and placed in trash receptacles at the facility.

Equipment Decontamination Fluids - Decontamination fluids from soil sampling will be collected and discharged to the sanitary sewer system.

Waste Soils from Soil Borings - Excess soil from hand augering or DPT operations produced during soil sampling will be drummed and retained onsite until soil analyses are provided for arsenic and heptachlor epoxide. If arsenic soil concentrations do not exceed 20x (see explanation below for the 20x factor) the TCLP extract limit (100mg/Kg) and heptachlor epoxide soil concentrations do not exceed 20x the TCLP extract limit (0.16mg/Kg) the soil will be returned to the boring hole to the extent possible with the remainder to be placed close to where the associated sample was collected and raked into the surface.

When a waste undergoes TCLP extraction, it effectively incurs a 20-fold dilution. To correctly compare TCLP extract analytical results with the TCLP limits requires multiplying the results by 20x to offset the dilution effect. The TCLP limits for arsenic and heptachlor epoxide using this 20x rule are based upon the following calculations and the fact that the TCLP procedure uses 100 grams (0.1kg) of soil - extracted into 2 liters of fluid:

Arsenic Calculation

- The TCLP extract limit for arsenic is 5mg/L; 20 x 5 (expressed as mg/kg) is 100mg/kg
- 100mg/kg of arsenic in a soil sample is equivalent to 10mg/100g (100mg x 0.1kg)
- 10mg of arsenic extracted into 2 liters of extract is equivalent to 5mg/L (10mg/2L = 5mg/L)
- Therefore, if the soil concentration of soluble arsenic is less than 100mg/kg, the TCLP extract limit of 5mg/L cannot be exceeded.

Heptachlor Epoxide Calculation

- The TCLP extract limit for heptachlor epoxide is 0.008mg/L; 20 x 0.008 (expressed as mg/kg) is 0.16mg/kg
- 0.16mg/kg of heptachlor epoxide in a soil sample is equivalent to 0.016mg/100g (0.16mg x 0.1kg)
- 0.016mg of heptachlor epoxide extracted into 2 liters of extract is equivalent to 0.008mg/L (0.016mg/2L = 0.008mg/L)
- Therefore, if the soil concentration of soluble heptachlor epoxide is less than 0.16mg/kg, the TCLP limit of 0.008mg/L cannot be exceeded.

4.10 RECORD KEEPING

In addition to COC records, certain standard forms will be completed for sample description and documentation. These forms shall include sample log sheets, daily activity records, and logbooks. A bound, weatherproof notebook shall be maintained by the FOL. All information related to sampling or field activities will be recorded in the field notebook. This information will include, but is not limited to, sampling time, weather conditions, unusual events, field measurements, and descriptions of photographs.

A bound, weatherproof logbook shall be maintained by the FOL. This book will contain a summary of each day's activities and will reference the field notebooks when applicable. At completion of the field activities, the FOL shall submit to the TOM all field records, data, field notebooks, logbooks, COC records, sample log sheets, and daily activity logs. Requirements for field documentation are outlined in SOP CTO 56-4 (Appendix B).

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
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SOIL SAMPLES FOR SWMU 7- OLD RIFLE RANGE

Sample I.D.	Sample Location (See Figures 4-2 and 4-3)	Sample Depth (feet bgs)	Laboratory Analytical Parameters	Sample Rationale
07-SB-01-0001	ORR- Hillside Boring 1	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-01-0204	ORR- Hillside Boring 1	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-02-0001	ORR-Hillside Boring 2	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-02-0204	ORR- Hillside Boring 2	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-03-0001	ORR- Hillside Boring 3	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-03-0204	ORR- Hillside Boring 3	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
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Sample I.D.	Sample Location (See Figures 4-2 and 4-3)	Sample Depth (feet bgs)	Laboratory Analytical Parameters	Sample Rationale
07-SB-04-0001	ORR- Berm 3 Boring 4	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-04-0204	ORR- Berm 3 Boring 4	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-05-0001	ORR- Berm 3 Boring 5	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-05-0204	ORR- Berm 3 Boring 5	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-06-0001	ORR- Berm 3 Boring 6	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-06-0204	ORR- Berm 3 Boring 6	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-07-0001	ORR- Berm 2 Boring 7	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
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Sample I.D.	Sample Location (See Figures 4-2 and 4-3)	Sample Depth (feet bgs)	Laboratory Analytical Parameters	Sample Rationale
07-SB-07-0204	ORR- Berm 2 Boring 7	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-08-0001	ORR- Berm 2 Boring 8	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-08-0204	ORR- Berm 2 Boring 8	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-09-0001	ORR- Berm 2 Boring 9	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-09-0204	ORR- Berm 2 Boring 9	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-10-0001	ORR- Berm 1 Boring 10	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-10-0204	ORR- Berm 1 Boring 10	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
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Sample I.D.	Sample Location (See Figures 4-2 and 4-3)	Sample Depth (feet bgs)	Laboratory Analytical Parameters	Sample Rationale
07-SB-11-0001	ORR- Berm 1 Boring 11	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-11-0204	ORR- Berm 1 Boring 11	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-12-0001	ORR- Berm 1 Boring 12	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-12-0204	ORR- Berm 1 Boring 12	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-13-0001	ORR- Krig Boring 13	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-13-0204	ORR- Krig Boring 13	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-14-0001	ORR- Krig Boring 14	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
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Sample I.D.	Sample Location (See Figures 4-2 and 4-3)	Sample Depth (feet bgs)	Laboratory Analytical Parameters	Sample Rationale
07-SB-14-0204	ORR- Krig Boring 14	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-15-0001	ORR- Krig Boring 15	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-15-0204	ORR- Krig Boring 15	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-16-0001	ORR- Krig Boring 16	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-16-0204	ORR- Krig Boring 16	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-17-0001	ORR- Krig Boring 17	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-17-0204	ORR- Krig Boring 17	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1
SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
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Sample I.D.	Sample Location (See Figures 4-2 and 4-3)	Sample Depth (feet bgs)	Laboratory Analytical Parameters	Sample Rationale
07-SB-18-0001	ORR- Krig Boring 18	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-18-0204	ORR- Krig Boring 18	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-19-0001	ORR- Krig Boring 19	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-19-0204	ORR- Krig Boring 19	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-20-0001	ORR- Krig Boring 20	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-20-0204	ORR- Krig Boring 20	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-21-0001	ORR- Krig Boring 21	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
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Sample I.D.	Sample Location (See Figures 4-2 and 4-3)	Sample Depth (feet bgs)	Laboratory Analytical Parameters	Sample Rationale
07-SB-21-0204	ORR- Krig Boring 21	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-22-0001	ORR- Krig Boring 22	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-22-0204	ORR- Krig Boring 22	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-23-0001	ORR- Krig Boring 23	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-23-0204	ORR- Krig Boring 23	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-24-0001	ORR- Krig Boring 24	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-24-0204	ORR- Krig Boring 24	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
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Sample I.D.	Sample Location (See Figures 4-2 and 4-3)	Sample Depth (feet bgs)	Laboratory Analytical Parameters	Sample Rationale
07-SB-25-0001	ORR- Krig Boring 25	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-25-0204	ORR- Krig Boring 25	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-26-0001	ORR- Krig Boring 26	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-26-0204	ORR- Krig Boring 26	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-27-0001	ORR- Krig Boring 27	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-27-0204	ORR- Krig Boring 27	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-28-0001	ORR- Krig Boring 28	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
PAGE 9 OF 15

Sample I.D.	Sample Location (See Figures 4-2 and 4-3)	Sample Depth (feet bgs)	Laboratory Analytical Parameters	Sample Rationale
07-SB-28-0204	ORR- Krig Boring 28	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
PAGE 10 OF 15**

SOIL SAMPLES FOR SWMU 7- OLD PISTOL RANGE

Sample I.D.	Sample Location (See Figure 4-4)	Sample Depth (feet bgs)	Analytical Parameters	Sample Rationale
07-SB-29-0001	OPR- Hillside Range 1 Boring 29	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-29-0204	OPR- Hillside Range 1 Boring 29	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-30-0001	OPR-Hillside Range 1 Boring 30	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-30-0204	OPR- Hillside Range 1 Boring 30	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-31-0001	OPR- Hillside Range 1 Boring 31	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-31-0204	OPR- Hillside Range 1 Boring 31	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
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Sample I.D.	Sample Location (See Figure 4-4)	Sample Depth (feet bgs)	Analytical Parameters	Sample Rationale
07-SB-32-0001	OPR- Berm Range 2 Boring 32	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-32-0204	OPR- Berm Range 2 Boring 32	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-33-0001	OPR- Berm Range 2 Boring 33	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-33-0204	OPR- Berm Range 2 Boring 33	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-SB-34-0001	OPR- Berm Range 2 Boring 34	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor Epoxide	Data Gap for Soils RFI
07-SB-34-0204	OPR- Berm Range 2 Boring 34	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-35-0001	OPR- Composite Sample from 3 Borings at Hillside Range 1 Firing Lane (Location C1)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
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Sample I.D.	Sample Location (See Figure 4-4)	Sample Depth (feet bgs)	Analytical Parameters	Sample Rationale
07-CP-35-0204	OPR- Composite Sample from 3 Borings at Hillside Range 1 Firing Lane (Location C1)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-36-0001	OPR- Composite Sample from 3 Borings at Hillside Range 1 Firing Lane (Location C2)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-36-0204	OPR- Composite Sample from 3 Borings at Hillside Range 1 Firing Lane (Location C2)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-37-0001	OPR- Composite Sample from 3 Borings at Hillside Range 1 Firing Lane (Location C3)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-37-0204	OPR- Composite Sample from 3 Borings at Hillside Range 1 Firing Lane (Location C3)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-38-0001	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C4)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
PAGE 13 OF 15**

Sample I.D.	Sample Location (See Figure 4-4)	Sample Depth (feet bgs)	Analytical Parameters	Sample Rationale
07-CP-38-0204	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C4)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-39-0001	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C5)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-39-0204	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C5)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-40-0001	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C6)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-40-0204	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C6)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-41-0001	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C7)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-41-0204	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C7)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
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Sample I.D.	Sample Location (See Figure 4-4)	Sample Depth (feet bgs)	Analytical Parameters	Sample Rationale
07-CP-42-0001	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C8)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-42-0204	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C8)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-43-0001	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C9)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-43-0204	OPR- Composite Sample from 3 Borings at Berm Range 2 Firing Lane (Location C9)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-44-0001	OPR- Composite Sample from 3 Borings at 55-Gallon Drum (Location C10)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-44-0204	OPR- Composite Sample from 3 Borings at 55-Gallon Drum (Location C10)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-45-0001	OPR- Composite Sample from 3 Borings at 55-Gallon Drum (Location C11)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

TABLE 4-1

**SUMMARY OF SOIL SAMPLING ACTIVITIES
NSWC CRANE, CRANE, INDIANA
PAGE 15 OF 15**

Sample I.D.	Sample Location (See Figure 4-4)	Sample Depth (feet bgs)	Analytical Parameters	Sample Rationale
07-CP-45-0204	OPR- Composite Sample from 3 Borings at 55-Gallon Drum (Location C11)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-46-0001	OPR- Composite Sample from 3 Borings at 55-Gallon Drum (Location C12)	0-1	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI
07-CP-46-0204	OPR- Composite Sample from 3 Borings at 55-Gallon Drum (Location C12)	2-4	As, Mn, Be, 2,4,6-Trinitrotoluene, 2,6-Dinitrotoluene, RDX, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Heptachlor epoxide	Data Gap for Soils RFI

Notes:

IDW – Investigation Derived Waste

NA – Not applicable

QA/QC sampling requirements are indicated in Table 4-2.

TABLE 4-2
SUMMARY OF SOIL SAMPLE ANALYSES
AND QUALITY CONTROL SAMPLES/MEASUREMENTS
OLD RIFLE RANGE⁽¹⁾
NSWC CRANE, CRANE, INDIANA

Parameter	No. of Environmental Samples	No. Field Duplicates ⁽²⁾	No. of Ambient Condition Blanks ⁽³⁾	No. of Rinsate Blanks ^(4, 5)	Source Water Blanks ⁽⁶⁾	No. of MS/MSDs ⁽⁷⁾	Total No. of Samples ⁽⁵⁾	Analysis Method
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SOILS

Old Rifle Range (Old Rifle Range Proper) Laboratory Analyses:								
Metals (total)	56	6	TBD	1+	TBD	3/3	69+	SW 6010B (Mn); SW 6020 (As, Be)
Energetics	56	6	TBD	1+	TBD	3/3	69+	SW 8330
PAHs	56	6	TBD	1+	TBD	3/3	69+	SW 8270C /SIM
Heptachlor Epoxide	56	6	TBD	1+	TBD	3/3	69+	SW 8081A
Old Rifle Range (Old Pistol Range) Laboratory Analyses:								
Metals (total)	36	4	TBD	1+	TBD	2/2	45+	SW 6010B (Mn); SW 6020 (As, Be)
Energetics	36	4	TBD	1+	TBD	2/2	45+	SW 8330
PAHs	36	4	TBD	1+	TBD	2/2	45+	SW 8270C /SIM
Heptachlor Epoxide	36	4	TBD	1+	TBD	2/2	45+	SW 8081A

- 1 Samples shown are for the initial rounds of sampling. Subsequent rounds of sampling will adhere to the same frequencies for QC sample collection but the total numbers of environmental samples and QC samples is likely to differ.
- 2 Field duplicate samples are collected at a minimum frequency of 1 per 10 environmental samples. Field duplicate soil samples must be selected to represent both sampling depths.
- 3 Ambient condition blanks will be collected at the discretion of the FOL to monitor site conditions. Because site conditions vary, totals are TBD.
- 4 Rinsate blanks are collected once per day for each source of final decontamination rinse water. Only one source of final decontamination rinse water is anticipated.
- 5 Plus sign (+) indicates potential for the total number of samples to increase, because of TBD variables.
- 6 Source water blanks will be collected at a frequency of 1 per water source per sampling event.
- 7 Extra sample volume for MS/MSD or MS/laboratory duplicate sample analyses will be collected at a frequency of 1 per 20 samples. For metals, MS and laboratory duplicates will be analyzed; for energetics, PAHs and heptachlor epoxide, a MS and a MSD will be analyzed. MS/MSD soil samples must be selected to represent both sampling depths.

MS/MSD Matrix spike/matrix spike duplicate
 NA Not Applicable
 TBD To be determined
 SW SW-846

NSWC Crane
 QAPP
 Revision: 2
 Date: October 2000
 Section: 4
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TABLE 4-3

**SUMMARY OF SAMPLE ANALYSES, CONTAINER TYPES AND VOLUMES,
PRESERVATION REQUIREMENTS, AND HOLDING TIMES
NSWC CRANE, CRANE, INDIANA**

Parameter	Sample Matrix	Sample Container	Container Volume	Preservation ⁽¹⁾	Maximum Holding Time ⁽²⁾	Analytical Methodology
Metals (As, Be, Mn)	Soil	Wide mouth glass with Teflon lid	8 oz ⁽³⁾	None required	Within 180 days	SW-846 Method 6010B or 6020
Energetics	Soil	Wide mouth glass with Teflon lid	8 oz ⁽³⁾	Cool to 4 °C	Extract within 14 days; analyze within 40 days of extraction	SW-846 Method 8330
Heptachlor Epoxide	Soil	Wide mouth glass with Teflon lid	8 oz ⁽³⁾	Cool to 4 °C	Extract within 14 days; analyze within 40 days of extraction	SW-846 Method 8081A
PAHs	Soil	Wide mouth glass with Teflon lid	8 oz ⁽³⁾	Cool to 4 °C	Extract within 14 days; analyze within 40 days of extraction	SW-846 Method 8270C/SIM

1 HNO₃ = Nitric Acid.

2 All holding times are from date of collection.

3 One 8-oz jar will provide ample sample volume for metals, energetics, heptachlor epoxide and PAH analyses. One additional jar will be collected for samples designated for MS/MSD analyses.

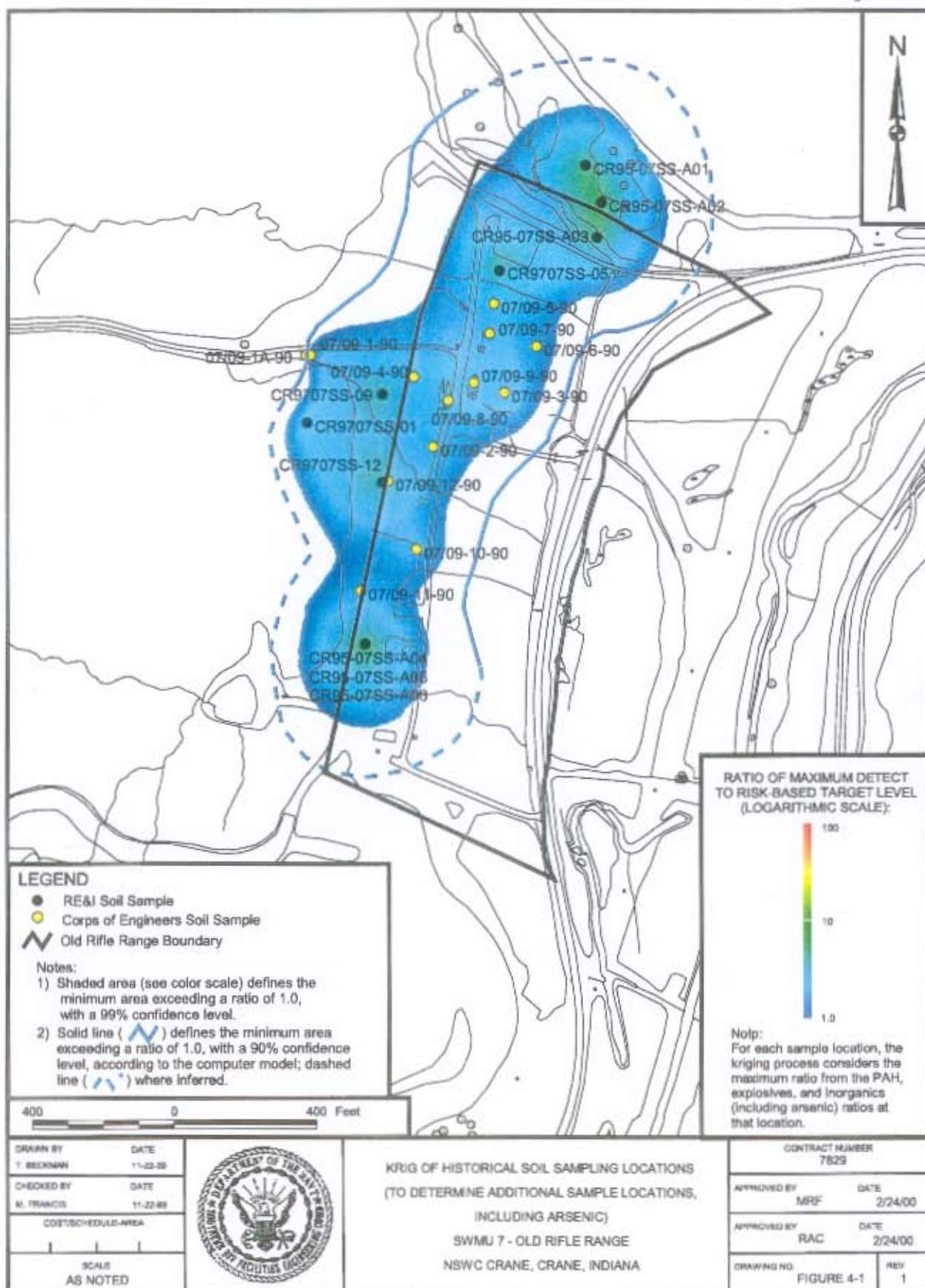
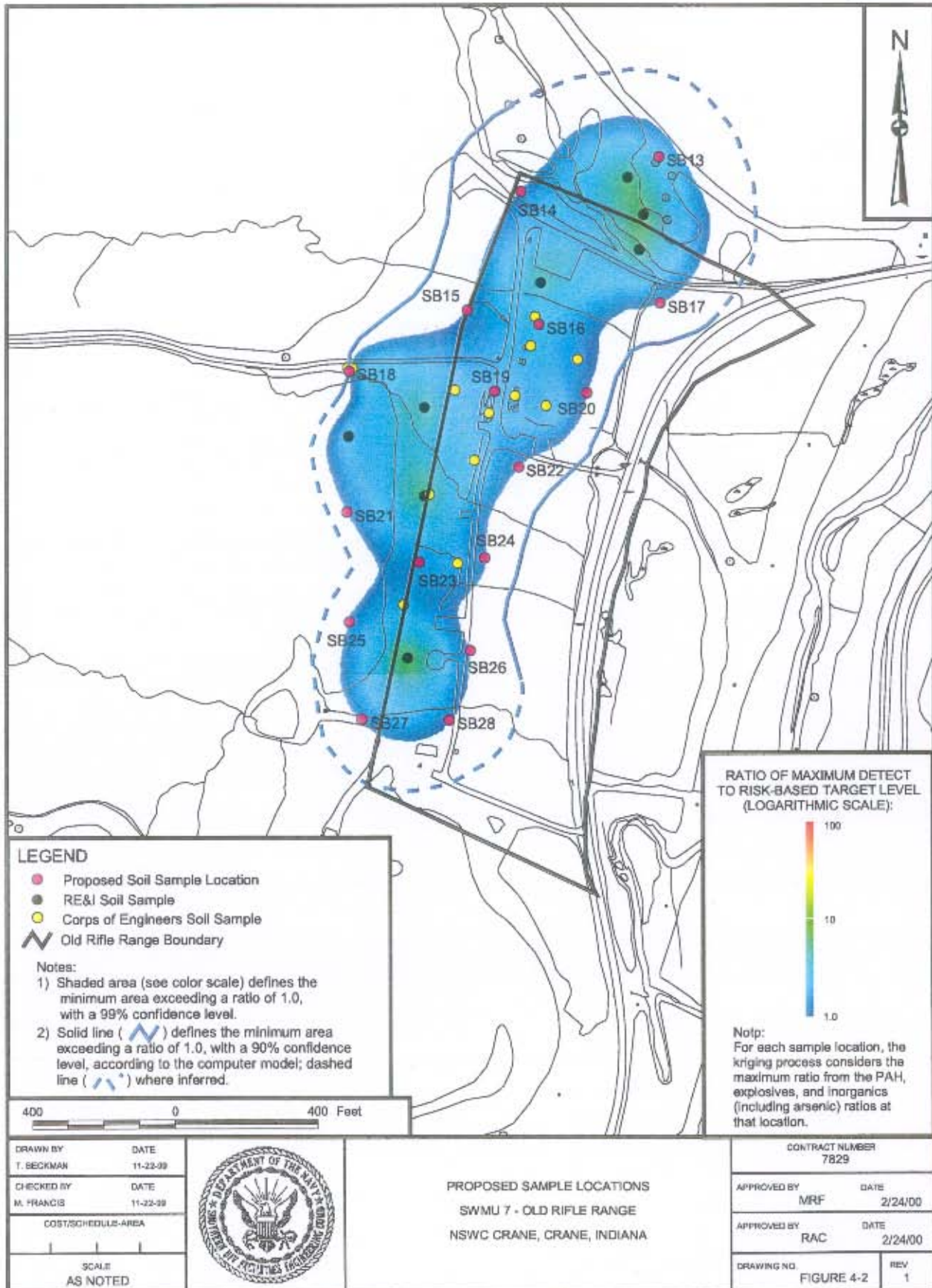


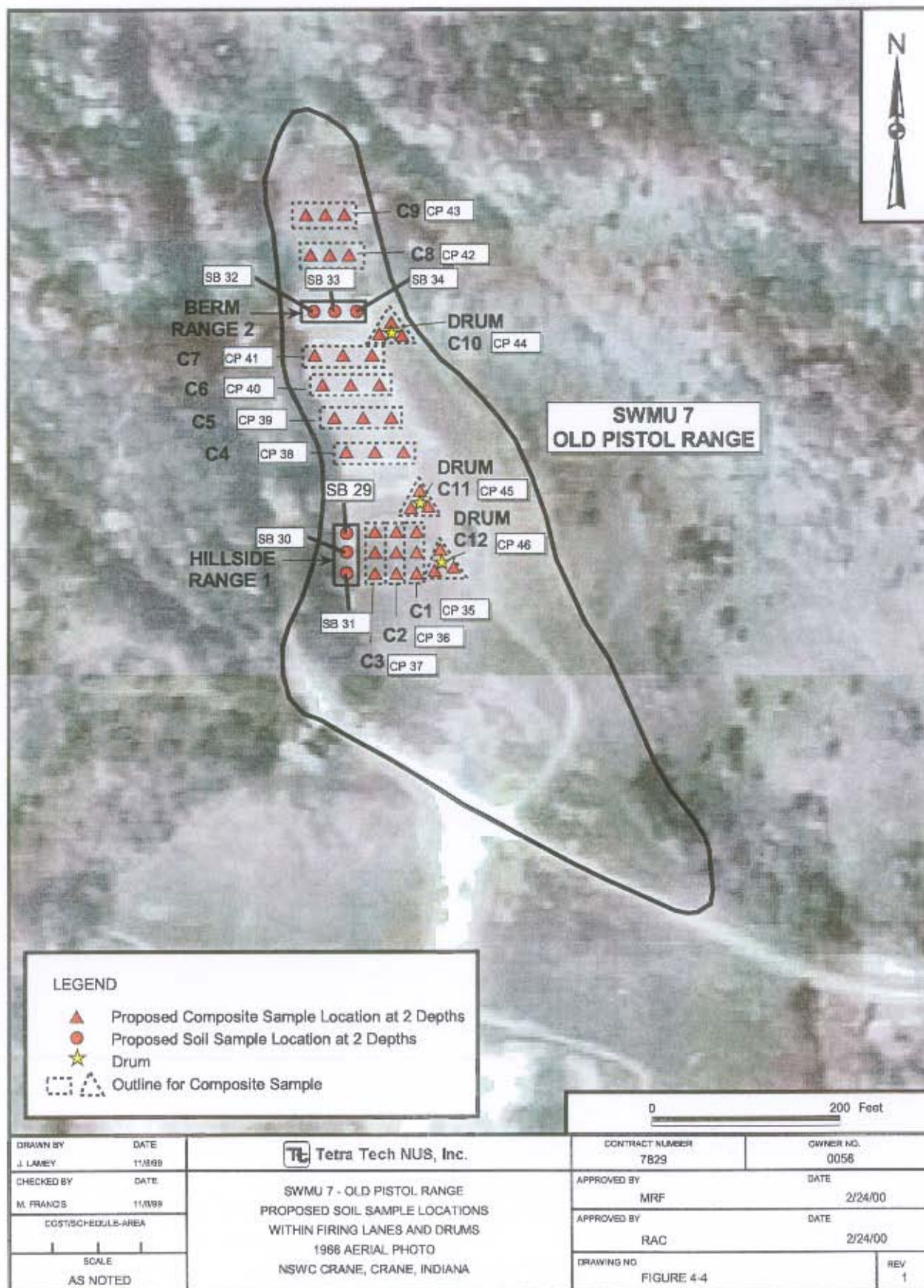
FIG 4-1 SWMUCRANE_KRIGED APR RATIO WITH ARSENIC LAYOUT - FIG 4-2 JUL 2000



P:\GIS\SVS\CRANE_EV\SVS.APR.RATIO WITH ARSENIC LAYOUT - FIG 4-3 2/24/00 JAL



P:\QIB\NSWC_CRANE\7829 APR. SWMU 7 (OLD RIFLE RANGE)-PROPOSED SOIL SAMPLE LOCATIONS 2/21/00 JAL



P:\GIS\NSWC_CRANE\7829.APR SWMU 7 (OLD PISTOL RANGE)-PROPOSED SOIL SAMPLE LOCATIONS 2/21/00 JAL

5.0 CUSTODY PROCEDURES

Documented sample custody is one of several factors that is necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, including all original laboratory reports and purge files, are maintained under document control in a secure area. A sample or evidence file is under custody when any one of the following conditions is satisfied:

- The item is in the actual physical possession of an authorized person.
- The item is in view of the person after being in his or her possession.
- The item was placed in a secure area to prevent tampering.
- The item is in a designated and identified secure area with access restricted to authorized personnel only.

The COC report is a multi-part, standardized form used to summarize and document pertinent sample information, such as sample identification and type, sample matrix, date and time of collection, preservation, and requested analyses. Furthermore, through the sequential signatures of various sample custodians (e.g., sampler, airbill number, laboratory sample custodian), the COC report documents sample custody and tracking. Laboratory custody procedures will ensure that sample integrity is not compromised from the time of receipt at the laboratory until final data are reported to TtNUS. This requires that the laboratory control all sample handling and storage conditions and circumstances. Custody procedures apply to all environmental and associated field QC samples obtained as part of the data collection system.

5.1 FIELD CUSTODY PROCEDURES

The FOL (or designee) is responsible for the care and custody of the samples collected until they are relinquished to the laboratory or entrusted to a commercial courier. COC forms are completed to the fullest extent possible for each sample cooler used for shipment. The forms are legibly completed with waterproof ink, and are signed (and dated) by the sampler. COC forms will include the following information: project name, sample number, time collected, matrix, designated analysis, type of sample, preservative, and name of sampler. Pertinent notes or comments are also indicated on the COC form. An example COC form is included in SOP CTO 56-4 (Appendix B).

Information similar to that contained on the COC form is provided on the sample label, which is securely attached to the sample bottle. In addition, sample tags will be affixed to the sample bottles and returned by the analytical laboratory for inclusion in the final evidence file. Sample labels and tags will include, at a minimum, the following information: sample number, date and time of collection, analysis required for the sample aliquot in the associated sample container, and a space for the laboratory sample number. The procedures for sample numbering by TtNUS are described in SOP CTO 56-6 (Appendix B), and the procedures for sample numbering by Laucks Testing Laboratories, Inc., are described in SOP LTL-4002 (Appendix C).

Site conditions during sampling and the care with which samples are handled may factor into the degree to which samples represent the media from which they are collected. This, in turn, could affect the ability of decision makers to make accurate and timely decisions concerning the contamination status of the site. As appropriate, logbooks are assigned to, and maintained by, key field team personnel. The logbooks are used to record daily conditions/activities such as weather conditions, dates/times of significant events, level of PPE used, boring activities, actual sample collection locations, photographs taken, problems encountered during field activities and corrective actions taken to overcome problems. In addition, the names of site visitors and the purposes of their visits shall be recorded. Field logbook assignments shall be recorded in the Site Logbook or other central file whose location is known by the FOL and the TOM. All field logbook assignments, use, control, and archiving are governed by SOP CTO 56-4 (Appendix B). Examples of all forms to be used during sampling activities are also provided in SOP CTO 56-4 (Appendix B). Together, field logbooks and sample documentation including COC forms provide a record that should allow a technically qualified individual to reconstruct significant field activities for a particular day without resorting to memory. The FOL is responsible for the maintenance and security of all field records at the end of each workday during field activities. At the completion of field activities, the FOL will forward all field records to the TtNUS TOM. All sample records are eventually docketed into the final evidence file.

SOP CTO 56-2 (Appendix B) describes procedures for soil sample packaging and shipment. A temperature blank shall be included in each cooler containing samples for use by the laboratory upon receipt. Each cooler shall be taped shut with strapping tape in at least two places to prevent tampering. Custody seals shall be attached as described in SOP CTO 56-4 so that the seals must be broken to open the cooler. Shipment will be made by a public courier at the next scheduled pickup following completion of sample collection.

The following procedures will be used when transferring custody of samples. As previously noted, individual custody records will accompany each sample cooler. The methods of shipment, courier name,

and other pertinent information will be entered in the remarks section of the custody record. When transferring samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the COC record. The original record (top copy of the multi-part form) will accompany the shipment and the field sampler will retain a copy. This record documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (common courier). After COC records have been placed within sealed shipping coolers, the signed courier airbills will serve to document COC. Upon arrival at the laboratory, internal laboratory sample custody procedures will be followed (see Section 5.2).

5.2 LABORATORY CUSTODY PROCEDURES

When Laucks Testing Laboratories, Inc., receives a shipment of samples, the laboratory's sample custodian will verify that the correct number of coolers has been received. The custodian will examine each cooler's custody seals to verify that they are intact and that the integrity of the environmental samples has been maintained. The custodian will then open each cooler and measure its internal temperature by measuring the temperature of the temperature blank. The temperature reading will be documented in the comments column of the COC form. In addition, the temperature reading will be recorded on the Supplemental Sample Receipt Log, as further explained below. The sample custodian will then sign the COC form and examine the contents of the cooler. Identification of broken sample containers or discrepancies between the COC form and sample labels will be recorded. The laboratory will retain the original field COC forms, providing copies of the forms with the final data package deliverable. A Laucks Testing Laboratories, Inc., CLP Sample Receipt Log and Supplemental Sample Receipt Log, as shown in Appendix 3 of SOP LTL-4002 (Appendix C), will be completed by Laucks Testing Laboratories, Inc. All problems or discrepancies noted during this process will be promptly reported to the TtNUS TOM. Samples will be logged into the laboratory information management system. Other pertinent issues relating to laboratory sample custody and tracking are presented in the following laboratory SOPs (Appendix C):

SOP LTL-1002	Document Tracking and Control
SOP LTL-1003	Chain-of-Custody and Documentation Procedures
SOP LTL-1007	Use of Instrument Records and Logbooks
SOP LTL-1013	Preparation, Storage, Shelf Life and Traceability Documentation of Standards and Reference Materials
SOP LTL-1019	Controlling, Maintaining, and Monitoring Laboratory Logbooks
SOP LTL-2001	Waste Segregation and Disposal
SOP LTL-4002	Electronic Sample Entry and Log-In

5.3 FINAL EVIDENCE FILES

The Administrative Record at NSWC Crane will be the repository for all documents that constitute evidence relevant to sampling and analysis activities as described in this QAPP. NSWC Crane will be the custodian of the evidence file and will maintain the contents of these files, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, and data reviews in a secure, limited-access location and under custody of the NSWC Crane Site Manager. The control file will include at a minimum:

- Field logbooks
- Field data and data deliverables
- Photographs and negatives
- Drawings
- Soil boring logs
- Laboratory data deliverables
- Data validation reports
- Data assessment reports
- Progress reports, QA reports, interim project reports, etc.
- All custody documentation (tags, forms, airbills, etc.)

Upon completion of the contract, all files associated with this investigation will be maintained in the Administrative Record at NSWC Crane and will be available for inspection by the regulatory agencies for at least six years. Prior to disposal of all administrative records, the records will be offered to the U.S. EPA.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

All instrumentation used to perform chemical measurements must be properly calibrated prior to use in order to obtain valid and usable results. Instruments used in the field and in the laboratory will be calibrated according to the procedures governing the use of the instruments. Field SOPs are included in Appendix B and laboratory SOPs are included in Appendix C. For this investigation, field instrument calibration is described in Section 6.1 and laboratory instrument calibration is outlined in Section 6.2.

6.1 FIELD INSTRUMENT CALIBRATION

At least one monitoring instrument will be used during field activities, including the following:

- PID/FID organic vapor detector.

The manufacturer's operating manual for this instrument is attached to SOP CTO 56-4.

All calibrations will be documented on an Equipment Calibration Log (SOP CTO 56-4, Appendix B). During calibration, an appropriate maintenance check will be performed on each piece of equipment. If damaged or defective parts are identified during the maintenance check and it is determined that the damage could have an impact on the instrument's performance, the instrument will be removed from service until the defective parts are repaired or replaced.

6.2 LABORATORY INSTRUMENT CALIBRATION

Calibration procedures for metals analyses by ICP/AES and ICP/MS begin with a periodic establishment of the useful linear response range followed by routine daily calibrations. The daily calibrations consist of atomic mass calibrations (ICP/MS only), at least one blank and one calibration standard, an initial calibration verification, and continuing calibration verification standards/blanks, with each batch of samples analyzed. In all cases, an independently prepared standard (i.e., from a second source or a different lot number from the primary source) will be used as a calibration verification solution or as the MS spiking mix.

Organic chemical analyses begin with an initial calibration of the gas chromatograph (GC) or gas chromatograph/mass (GC/MS) spectrometer system with an initial calibration curve that establishes the instrument responses as functions of analyte concentration. The initial calibration curves incorporate a calibration blank and a series of calibration standards for the target analytes and any applicable internal

standards or surrogate compounds. On a routine basis, a continuing calibration is performed in which the validity of the calibration curve is checked with a known chemical standard of a source independent of the initial calibration standards. This continuing calibration standard contains the target analytes of interest and applicable internal standards and surrogate compounds. The internal standards compensate for variations in analytical response that may occur in individual chromatographic analyses. The surrogate compounds provide a means to assess the efficiency of analyte extraction and analysis for each sample.

All standards used to calibrate analytical instruments must be obtained from the National Institute of Standards and Technology (NIST) or through a reliable commercial supplier with a proven record for quality standards. All commercially supplied standards will be traceable to NIST reference standards, where possible, and appropriate pedigree documentation will be obtained from the supplier. In cases where documentation is not available, the laboratory will analyze the standard and compare the results to a U.S. EPA-known or previous NIST-traceable standard.

Calibrations and associated documentation are required for all laboratory instruments. The documentation for calibrations performed in-house shall identify the person performing the calibration, the instrument being calibrated, the standards used for calibration and their concentration values or other pertinent calibration values, the source of the calibration standards, and the date of calibration. Certain instruments (e.g., balances) may be calibrated by a third party. In those cases the details of calibration as described above, and a certification of acceptable performance shall be obtained from the third party. The period during which the calibration is valid may appear in the calibration record or may be governed by SOP.

Calibration procedures, frequency requirements, acceptance criteria, and conditions that require recalibration are described for each analytical procedure in the applicable laboratory SOPs included in Appendix C.

7.0 ANALYTICAL AND MEASUREMENT PROCEDURES

Field measurements and analytical procedures are presented in this section.

7.1 FIELD MEASUREMENT PROCEDURES

Parameters to be measured using field instrumentation include volatile organic compounds. Measurement of field parameters is described in detail in Section 4. Calibration of field instruments is discussed in Section 6 and in individual field measurement SOPs (Appendix B).

7.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES

Table 7-1 provides a summary of the laboratory analytical methods and associated laboratory SOPs to be used during this investigation. Laboratory SOPs are included in Appendix C of this QAPP.

7.2.1 List of Project Target Compounds and Detection Limits

A list of the laboratory target analytes; project-specific risk-based target levels; and laboratory-specific MDLs (all parameters except metals), IDLs (metals only), and RLs is provided on Table 1-7. The MDLs shown have been determined experimentally using the procedures described in Section 6.3 of Laucks Testing Laboratories, Inc., SOP LTL-1011 which is included in Appendix C of this QAPP. These procedures are based on the method provided in 40 CFR Part 136 Appendix B (FR, 1984). The IDLs provided for metals have been experimentally determined as described in Section 6.2.6 of Laucks Testing Laboratories, Inc., SOP LTL-1011. This procedure is based on the procedure for IDL determination as specified in the U.S. EPA Contract Laboratory Program (CLP) (U.S. EPA, 1995). All environmental data will be reported to the analyte's laboratory-specific RL. An analyte's RL is based on the associated MDL/IDL with adjustments made to ensure that the precision and accuracy requirements of the method are attainable. RLs will be adjusted on a sample-by-sample basis, as necessary, based on dilutions, sample volume and, for soil samples, percent moisture.

7.2.2 List of Associated Quality Control Samples

Field and laboratory QC samples to be analyzed in support of this project are identified in Section 8.0. The analytical SOPs included in Appendix C of this QAPP address minimum QC requirements for each associated analytical method. The SOPs include calibration QC requirements. Details on QC sample usage are provided in Section 8.0.

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TABLE 7-1
SUMMARY OF ORGANIC AND INORGANIC ANALYTICAL PROCEDURES
SOLID SAMPLES
NSWC CRANE, CRANE, INDIANA

Analytical Parameter	Preparation Method	Analytical Method	Preparation/Analytical SOP(s) ⁽¹⁾
2,6-Dinitrotoulene Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) 2,4,6-Trinitrotoluene	SW-846 ⁽²⁾ 8330	SW-846 8330	LTL-3161/LTL-8330
As and Be - total	SW-846 3050B (no HCl)	SW-846 6020	LTL-7015/LTL-7202
Mn - total	SW-846 3050B	SW-846 6010B	LTL-7015/LTL-7105
Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene	SW-846 3550B	SW-846 8270C with SIM	LTL-3100/LTL-8277
Heptachlor epoxide	SW-846 3550B	SW-846 8081A	LTL-3302/LTL-8084

- 1 Laboratory SOPs are included in Appendix C of this QAPP.
2 U.S. EPA, 1986.

8.0 INTERNAL QUALITY CONTROL CHECKS

Field and laboratory QC samples will be analyzed routinely to evaluate overall data quality. This section provides information regarding those internal QC checks. Laboratory QC samples are addressed in Sections 6.0 and 8.2 of this QAPP. Section 6.0 addresses instrument calibrations; Section 8.2 addresses non-calibration analytical QC. Table 8-1 summarizes the routine field and laboratory non-calibration QC sample analysis frequencies and associated corrective actions. Table 4-2 of Section 4 presents the numbers of QC samples that are anticipated to be collected in the field.

8.1 FIELD QUALITY CONTROL CHECKS

TtNUS has established a QC program that is designed to monitor and assess the quality of field work performed during environmental investigations. That program includes the use of various types of QC samples as indicated in Table 8-1. Some of the samples in Table 8-1 are identified as requiring additional sample material to be collected in the field even though the actual field QC check is performed in the laboratory.

The field QC samples consist of field duplicates, equipment rinsate blanks, source water blanks temperature blanks and, at the discretion of the FOL, ambient condition blanks. Temperature blanks will be included in each cooler submitted to the laboratory to monitor sample storage conditions prior to arrival at the laboratory. However, a temperature blank is not required for samples that will be analyzed only for the three project target metals. With the exception of temperature blanks, each type of field QC sample undergoes the same preservation, analysis, and reporting procedures as the related environmental samples. The types of field QC samples to be used for this project are described in detail in Sections 8.1.1 through 8.1.6. Target precision and accuracy values, as applicable, for field QC samples are presented in Table 3-2.

8.1.1 Source Water Blanks

Source water blanks are obtained by sampling the analyte-free water and/or potable water source(s) used for decontaminating sampling equipment. Source water blanks are used to determine whether the analyte-free water (used for sampling equipment decontamination procedures) or the potable water (used for steam cleaning) may be contributing to sample contamination.

8.1.2 Field Duplicates

Field duplicates will be collected and analyzed for chemical constituents to measure the cumulative uncertainty (i.e., precision) of the sample collection, splitting, handling, storage, preparation and analysis operations, as well as natural sample heterogeneity that is not eliminated through simple mixing in the field. Field duplicates are two samples prepared by mixing a volume of sample and splitting it into two separate sample containers that are labeled as individual field samples. Field duplicates are labeled as individual environmental samples and are not identified to the laboratory as duplicate samples.

8.1.3 Rinsate Blanks

Equipment rinsate blanks or rinsate blanks are obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through sample collection equipment after sampling and decontamination and prior to use. These blanks will be collected to indicate the potential for sample cross-contamination through the use of improperly cleaned sampling equipment.

8.1.4 Trip Blanks

No trip blanks will be used for this investigation because they are useful only for VOC analyses, and no VOC analyses will be performed as part of this investigation.

8.1.5 Ambient Condition Blanks

Ambient condition blanks are samples of deionized water poured from one container to another in the field to detect the infiltration of airborne contaminants into field samples. These samples will be used at the discretion of the FOL if the FOL believes that such infiltration is a possibility based on site conditions.

8.1.6 Temperature Blanks

Temperature blanks are vials of water inserted into each sample cooler prior to shipment from the field. The temperature of the temperature blank is measured prior to shipment and upon receipt at the laboratory to assess whether samples were properly cooled during transit.

8.2 LABORATORY QUALITY CONTROL CHECKS

Laucks Testing Laboratories, Inc. operates a QC program that ensures the reliability and validity of the analyses performed at the laboratory. The laboratory's QA Plan describes the policies, organization, objectives, QC activities, and specific QA functions employed by the laboratory. All analytical procedures

are documented in writing as SOPs. Each analytical SOP specifies minimum QC requirements for the procedure. As previously noted, SOPs for all analyses to be performed during this investigation are included in Appendix C of this QAPP. Table 7-1 provides a list of the SOPs associated with each analytical procedure. In addition, the laboratory maintains SOPs regarding general laboratory QA operations. Several of these SOPs, as applicable, are also included in Appendix C. The Table of Contents included in Appendix C provides a list of laboratory SOP titles and associated SOP numbers for all SOPs contained in the appendix.

Internal laboratory analytical QC requirements beyond those used for instrument calibration QC are highlighted in the remainder of this section. Additional QC requirements, which are specific to the NFESC QA Program, and are therefore requirements for this project, are also specified, as applicable, for each of the QC checks. Target precision and accuracy values (control limits) are presented in Tables 3-1 and 3-3. The applicable analytical SOPs should be consulted for a discussion of calibration QC measures.

8.2.1 Laboratory Control Samples

LCSs provide a means to monitor the overall performance of each step during the analysis, including the sample preparation. These are solid samples (soil analyses) or blank spikes (water analyses) that contain concentrations of analytes that are known with a specified degree of certainty.

Based on the requirements of the NFESC QA Program, LCSs for metals analyses must contain all analytes of interest, whereas LCSs for multiple-analyte organic methods must contain at least two targeted analytes from each major class of compounds subject to analysis. Because the target analyte list for this project is small, all target analytes for inorganics and organic methods will be included in the LCSs. The complete target analyte list of explosives (three compounds) will be included in the LCSs associated with explosives analysis. The complete target analyte list of PAHs (five compounds) will be included in the LCSs for these analyses. Heptachlor epoxide will be included in the spiking list for pesticide analyses. Other pesticide compounds may be included but will not be used for quality control.

Based on NFESC QA Program requirements, if recovery of an LCS falls outside the control limits (See Table 3-3), the laboratory will reject the data for the analytical batch and take corrective action. The associated samples, extracts, or digestates may be reanalyzed a single time, and if the LCS recoveries meet acceptance criteria, the data will be reported. If LCS analyte recovery is still outside the acceptance limits, the associated samples in the preparation batch will be reprocessed if sufficient sample is available and holding times have not lapsed. If re-preparation or reanalysis is not possible, the data will be flagged and the sample delivery group (SDG) narrative will include details of the failed LCS.

8.2.2 Laboratory Duplicates

Laboratory duplicates will be analyzed for metals to measure the cumulative uncertainty (i.e., precision) of the sample handling, subsampling, preparation, laboratory storage, and analysis operations within the laboratory, as well as sample heterogeneity that is not eliminated through simple mixing in the laboratory. Laboratory duplicates are two subsamples obtained by the laboratory analyst after mixing the sample. If RPD values exceed QC limits for laboratory duplicates (Table 3-1), the analytical process will be investigated to assess whether the observed RPD value is an indication of a deficient analytical system or an indication of excess sample heterogeneity.

8.2.3 Internal Standards

Internal standards are added to each sample analyzed by GC/MS to ensure that the analysis sensitivity and response are stable during every analytical run. Internal standard area counts for samples and blanks must not vary by more than a factor of two (- 50% to + 100%) from the associated 12-hour calibration standard.

8.2.4 Laboratory Method Blanks

Laboratory method blanks or preparation blanks are an analyte-free matrix prepared and analyzed in accordance with the analytical method employed to determine whether contaminants originating from laboratory sources have been introduced and have affected environmental sample analyses. Analyte-free water is used as a blank for water analyses. A method blank for organic soil sample analysis consists of an aliquot of sand (or in some cases sodium sulfate) that is subjected to the same preparation and analysis as the environmental samples. The solid method blank results are presented on a dry-weight basis assuming 100% solids. Native soils devoid of acid leachable metals do not exist. Therefore, a method blank for inorganic soil sample analysis consists of an aliquot of analyte-free water that is subjected to the same preparation and analysis procedures as the environmental samples undergoing analysis. The aqueous results are normalized to a fictitious soil sample and presented on a dry weight basis assuming 100% solids.

Laboratory method blanks acceptance criteria and corrective actions for non-compliant results are described in detail in the applicable analytical SOP included in Appendix C. Under no circumstances are laboratory method blank contaminant values subtracted from environmental sample analysis results.

8.2.5 Matrix Spikes

MSs are environmental samples to which known quantities of analytes are added prior to sample digestion. These samples provide information about the heterogeneity of the samples as well as the effect of the sample matrix on the sample digestion and measurement methodology.

Matrix spikes, to conform with NFESC requirements, will contain all the targeted analytes of interest. If the MS recovery is not within applicable control limits, the laboratory will assess the batch to determine whether the spike results are attributable to a matrix effect or are the result of other problems in the analytical process. Based on NFESC requirements, if all the batch QC elements which are not affected by the sample matrix are in control (e.g., method blank, LCS, calibration checks) and if there is no evidence that spiking was not properly performed, the poor spike recovery may be attributed to matrix effects. In this case, the associated data will be flagged, but re-preparation and re-analysis will not be required. If any of the batch QC elements which are not affected by the sample matrix are out of control, or if there is any evidence that spiking may have been improperly performed, the MS sample will be re-processed through the entire analytical sequence. If there is insufficient sample available, or if holding times have passed, the laboratory will flag the associated data. Details of noncompliant and laboratory duplicate results will be included in the SDG narrative.

8.2.6 Matrix Spike Duplicates

MSDs are duplicates of matrix spikes and are used for estimating the precision of organic target analyte analyses. They are used in lieu of simple duplicate samples because native environmental samples frequently do not exhibit detectable levels of organic target analytes, which otherwise prevents the calculation of RPD values.

8.2.7 Post Digestion Spikes

PDSs are similar to MSs except that the sample digestate, rather than the original soil sample, is spiked. These spikes are only analyzed for metal target analytes if the matrix spike recovery falls outside control limits; they are not typically analyzed for organic target analytes. Comparing %Rs for PDSs and MSs helps to identify where in the analytical process accuracy problems are occurring. PDSs will contain all target analytes of interest and will be used to assist in determining whether unacceptable MS recoveries are a result of matrix effects.

8.2.8 Surrogates

Surrogates are organic compounds (typically brominated, fluorinated, or isotopically labeled) which are similar in nature to the compounds of concern and are not likely to be present in environmental media. They are spiked into each sample, standard, and method blank before analysis, and are used in organic chromatographic analysis procedures as a check of method effectiveness. Corrective actions for noncompliant surrogate recoveries are presented in the relevant determinative SOPs included in Appendix C of this QAPP. Details of noncompliant surrogate recoveries will be included in the SDG narrative.

8.2.9 Additional Laboratory QC Checks

Additional internal laboratory QC checks include mass tuning for GC/MS analysis and second-column confirmation for GC analysis. Specific QC requirements for each of these QC checks are provided in the applicable SOPs included in Appendix C of this QAPP.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

This section describes the procedures to be used for data reduction, validation, and reporting. Data generated during the course of the field investigations will be maintained in hard copy form in the Administrative Record at NSWC Crane.

9.1 DATA REDUCTION

9.1.1 Field Data Reduction Procedures

All field logs containing observations will be inspected and approved by the FOL. All field observations will be recorded in the logs immediately after observations are made.

If errors are made in recording or transcribing observations, erroneous observations will be legibly crossed out using a single line, initialed, dated by the field member, and corrected in a space adjacent to the crossed-out entry. The FOL has responsibility to assure that errors are identified and assessed relative to the intent of the QAPP.

Errors judged to affect the utility of the sample results within the context of this investigation shall be brought to the immediate attention of the TOM.

9.1.2 Laboratory Data Reduction Procedures

Data reduction will be completed by Laucks Testing Laboratories, Inc. in accordance with the method-specific laboratory SOPs included in Appendix C. In addition, SOP LTL-1018 (Appendix C) presents the procedures that will be used by Laucks Testing Laboratories, Inc., for review and approval of data.

Laboratory analytical data will be reported using standard concentration units to ensure comparability with previous analytical results. Soil sample results will be reported on a dry-weight basis in units of micrograms per kilogram ($\mu\text{g}/\text{kg}$) for organic parameters and milligrams per kilogram (mg/kg) for metals.

9.2 DATA VALIDATION

Validation of field measurements and laboratory analytical data are presented in this section.

9.2.1 Procedures Used to Validate Field Data

Field measurements will not be subjected to a formal data validation process. Validation of field data will be limited to real time inspection by the FOL of observations relative to actual site conditions and activities. In addition, field technicians will ensure that the equipment used for sample collection is performing adequately via compliance with the applicable SOPs.

9.2.2 Procedures Used to Validate Laboratory Data

One hundred percent of the laboratory analytical data will be subjected to data validation to ensure that the data are of evidentiary quality. Validation of analytical data will be completed by the TtNUS Environmental Chemistry/Toxicology Department located in TtNUS's Pittsburgh office. Final review and approval of validation deliverables will be completed by the Department's Data Validation Manager.

Prior to statistical analyses, analytical results will be validated *versus* the applicable analytical methods, the SOPs included in Appendix C, and the requirements of this QAPP. Validation of these data will conform to the U.S. EPA Region 5 Standard Operating Procedures for Validation of CLP Inorganic and Organic Data (U.S. EPA, 1993a/b) and the National Functional Guidelines for Inorganic and Organic Data Review (U.S. EPA, 1994a and 1999b) to the greatest extent practicable. Data validators will review the chemical analytical data packages submitted by the laboratory. The data validators will check that the data were obtained using approved methodology, that the appropriate level of QC and reporting was conducted, and that the results are in conformance with QC criteria. For the three explosive compounds to be investigated as part of this RFI, the general logic used in EPA CLP guidelines, analytical objectives outlined in other sections of this QAPP, and SW-846 method 8330 requirements themselves will be used to validate explosive compound results.

On the basis of the data validation results, the data validator will generate a report describing detected data limitations. The report will be reviewed internally by the Data Validation Manager prior to submittal to the TOM. Data review will be extended beyond this routine validation by involving the project chemist, statistician, and risk assessor, as appropriate, to examine the data for anomalies (See Section 12.4). This additional review may result in more detailed inspections of the data to determine the cause of, and to rectify, individual anomalies. The impact of data qualifiers on data usability will also be assessed and any qualifications that are indicated during use of the data shall be documented in the RFI report.

The data validation process will provide an estimate of the number of usable data points. This completeness check will be effected by computing the number of data points that are rejected relative to the total number of data points for a given analyte in a given environmental medium.

9.3 DATA REPORTING

9.3.1 Field Data Reporting

Field data will be transferred manually from the site logbook or sample logsheets to the electronic database and will be reviewed for accuracy by an independent reviewer.

All records regarding field measurements (i.e., field logbooks, sampling logbooks, and sample logsheets) will be placed in the TtNUS central files upon completion of the field effort. Entry of these results in the database will require removal of these records from the files. Outcards (date, person, subject matter) will be used to document the removal of any such documentation from the files. After database entry is complete, all records will be copied for placement in TtNUS central files. All original records will be sent to NSWC Crane for inclusion in the final evidence files, as described in Section 5.3.

9.3.2 Laboratory Data Reporting

To achieve the investigation objectives, a confirmational level of analytical quality is needed. This provides the highest level of data quality necessary to address potential risks. These analyses require full documentation of the chosen U.S. EPA SW-846 analytical methods and sample preparation steps, data packages, and data validation sufficient to provide defensible data. QC must be sufficient to define the overall precision and accuracy of these procedures. Therefore, data reported by Laucks Testing Laboratories, Inc. for all analytical fractions will be in a CLP-like reporting format. Hard copy data deliverables shall be generated at the time of analysis. All pertinent QC data including raw data and summary forms for blanks, standards analysis, calibration information, etc., will be provided for all analyses. Case narratives will be provided for each SDG. SOP LTL-4201 (Appendix C) provides further details regarding the information that will be included in CLP-type packages produced by Laucks Testing Laboratories, Inc.

Validation will be completed using the hard copy data. Upon completion of validation of a SDG and review by the Data Validation Manager, the validation qualifiers will be entered into the electronic database and will be subjected to independent review for accuracy. During this review process, the electronic database printout also will be compared with the hard copy data to ensure that the hard copy data and electronic data are consistent.

9.3.3 Project Reports

With each round of data collection, data will be summarized and assessed to determine whether additional data collection is required for determining the extent of contamination at the ORR. Although not part of the scope of work for this investigation, a Phase III RFI report will be issued summarizing the findings of the investigation when no more data collection is necessary. If detected, the location, concentrations and boundaries of contaminants will be described and depicted on summary maps and diagrams, as appropriate. The results of statistical tests will be presented summarizing the measured soil concentrations relative to background soil concentrations and RBTs for SWMU 7. Discussions with U. S. EPA Region 5 concerning the need for future investigations will be summarized and, if appropriate, recommendations for future investigations will be presented.

Recipients of the Phase III RFI report will include EPA Region 5, IDEM, the Navy Southern Division, and NSWC Crane.

9.4 DATA ACQUISITION REQUIREMENTS AND DATA MANAGEMENT

The overall data management scheme and specific requirements for database content, format and integrity are presented in the TtNUS CTO-56 Data Management Plan (Appendix E). A brief summary is presented in the following paragraphs.

Data acquisition and management begins with the identification and collection of past data and newly acquired project samples. The samples are labeled and tagged, packaged for shipment, and shipped to the analytical laboratory in accordance with TtNUS SOPs as provided in Appendix B. The samples are received at the laboratory and analyzed, the analytical results are reported by the analyst along with QC check data, and the data are reviewed within the laboratory, according to laboratory SOPs as provided in Appendix C. Data are then transmitted from the laboratory in both hardcopy and electronic formats according to laboratory SOPs as provided in Appendix C. The data deliverable requirements are specified in TtNUS's Basic Ordering Agreement with analytical laboratories. This agreement requires the analytical laboratory to provide data in both hardcopy and electronic form. Upon receipt by TtNUS, the data are validated, analyzed, assessed, and ultimately archived.

The electronic database will include pertinent sampling information such as sample number, sampling date, sample point location, as well as analytical information. Sample-specific RLs will be reported for nondetected analytes. Units will be clearly summarized in the database and will conform to those

identified in Section 9.1.2. The original electronic diskettes and data validation reports for this investigation will be maintained in the Administrative Record at NSWC Crane, and copies will be maintained in TtNUS central files.

10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits will be conducted periodically to ensure that work is being implemented in accordance with the approved QAPP and in an overall satisfactory manner. Some examples of pertinent audits are:

- The FOL will supervise and check daily that the field observations are made accurately, equipment is thoroughly decontaminated, samples are collected and handled properly, and fieldwork is documented accurately and neatly.
- The TOM will maintain contact with the FOL and Data Validation Manager to ensure that management of the acquired data proceeds in an organized and expeditious manner.

Details regarding additional audit responsibilities, frequency, and procedures are provided in the remainder of this section. Field performance and system audits are addressed in Section 10.1. Laboratory performance and system audits are addressed in Section 10.2.

10.1 FIELD PERFORMANCE AND SYSTEM AUDITS

This section presents the responsibilities, frequencies, and procedures associated with internal and external field performance and system audits.

10.1.1 Internal Field Audits

10.1.1.1 Internal Field Audit Responsibilities

In addition to the daily checks performed by the FOL, the TtNUS QAM or designee may conduct an independent performance and system audit of field activities. Such audits are scheduled as part of the NSWC Crane RCRA Environmental Investigation Program, which includes this and other environmental projects, with individual projects being selected for audit by the QAM without the involvement of the TOM. If a formal field audit is conducted for this study, the QAM (or designee) will be responsible for ensuring that sample collection, handling, and shipping protocols, as well as equipment decontamination and field documentation procedures, are being performed in accordance with the approved QAPP and SOPs.

10.1.1.2 Internal Field Audit Frequency

As explained in Section 10.1.1.1, internal field audits are scheduled as part of the NSWC Crane RCRA Environmental Investigation Program, which includes this and other environmental projects. Individual projects are selected for audit by the QAM without the involvement of the TOM.

10.1.1.3 Internal Field Audit Procedure

Internal field audits will be conducted in accordance with the following procedure:

- Prior to an audit, the auditor will prepare a detailed checklist to be used as an auditing guide. An example audit checklist is provided in Appendix F.
- Upon arrival at the audit location, the auditor shall conduct a pre-audit meeting with the responsible management of the organization or project to be reviewed.
- Field audits will include a review of required project documentation (logbooks, sample log sheets, etc.) and field operations (sample COC, sample handling, etc.) to evaluate completeness and compliance with applicable SOPs.
- The audit checklist will be used to record observations including any noted non-conformances.
- A formal post-audit debriefing will be conducted, and potential immediate corrective actions will be discussed.
- The auditor will generate a formal audit report that will address corrective actions. The auditor will provide this report to the TOM.
- The TOM will ensure that all corrective actions are addressed and will provide written verification of corrective action implementation to the auditor.
- The auditor will manage corrective action verification and audit closure.
- The following audit records will be maintained by the QAM:

- Audit checklists
- Audit reports
- Response evaluations
- Verification of corrective actions
- Follow-up checklists and audit reports

10.1.2 External Field Audits

10.1.2.1 External Field Audit Responsibilities

The IDEM, the U.S. EPA Region 5, or both may conduct external field audits.

10.1.2.2 External Field Audit Frequency

External field audits may be conducted at any time during field activities at the discretion of the IDEM and U.S. EPA Region 5. If an audit is to be conducted, scheduling should be coordinated through the TtNUS QAM to ensure that personnel and equipment are available as necessary. Personnel being audited may or may not be informed of the impending audit at the discretion and request of the auditing body.

10.1.2.3 Overview of the External Field Audit Process

External audit procedures are at the discretion of U.S. EPA Region 5 and the IDEM.

10.2 LABORATORY PERFORMANCE AND SYSTEMS AUDITS

This section presents the responsibilities, frequencies, and procedures associated with internal and external laboratory performance and system audits.

10.2.1 Internal Laboratory Audits

10.2.1.1 Internal Laboratory Audit Responsibilities

The QAO or appropriate designee of the subcontracted laboratory performs routine internal audits of the laboratory. The U.S. Navy, through the NFESC, also conducts internal laboratory audits. TtNUS holds no responsibility for such audits. Performance and system audits of laboratories are coordinated through the NFESC by an independent QA contractor. It is the responsibility of the NFESC and its contractor to ensure that the subcontracted laboratory complies with good laboratory practices and the general requirements of all analytical services provided by the laboratory.

10.2.1.2 Internal Laboratory Audit Frequency

Internal audits are performed approximately annually at Laucks Testing Laboratories, Inc. In addition, each laboratory department at Laucks Testing Laboratories, Inc., analyzes blind performance evaluation (PE) samples as described in SOP LTL-1009 (Appendix C). The Laucks Testing Laboratories QAO or designee also performs data audits at least once per year for each analytical area.

The U.S. Navy completes internal laboratory performance and system audits for each contracted laboratory on an 18-month schedule.

10.2.1.3 Internal Laboratory Audit Procedures

Internal systems audits are conducted to detect any problems in sample flow, analytical procedures, or documentation and to ensure adherence to laboratory SOPs. The Laucks Testing Laboratories, Inc., internal audit procedures are described in SOP LTL-1017 (Appendix C).

Internal U.S. Navy laboratory audit procedures, as performed by a Navy contractor, include a pre-screening process which requires review of the laboratory's QA Plan, analysis of performance evaluation samples, generation of data deliverables for those samples, an onsite technical systems audit of the laboratory, and satisfactory resolution of all deficiencies and findings.

10.2.2 External Laboratory Audits

10.2.2.1 External Laboratory Audit Responsibilities

The IDEM and U.S. EPA Region 5 may perform external audits at their discretion. U.S. EPA Region 5 has recently audited Laucks Testing Laboratories, Inc., for another related U.S. Navy Crane project, and the outcome was favorable.

Laucks Testing Laboratories, Inc., is also involved in various other external audits and performance evaluation studies throughout the year, as required, to maintain certifications and/or approvals by other regulatory agencies or programs.

10.2.2.2 External Laboratory Audit Frequency

U.S. EPA Region 5 or IDEM may conduct an external laboratory audit prior to or during sampling and analysis activities.

10.2.2.3 Overview of the External Laboratory Audit Process

External audit procedures are at the discretion of U.S. EPA Region 5 and the IDEM. External laboratory audits may include (but are not limited to) review of laboratory analytical procedures, laboratory onsite audits, and/or submission of PE samples to the laboratory for analysis.

11.0 PREVENTIVE MAINTENANCE PROCEDURES

Equipment used to collect samples will be maintained in accordance with the manufacturers' operation and maintenance manuals. Equipment and instruments will be calibrated in accordance with the procedures and at the frequency presented in Section 6.0 (Calibration Procedures and Frequency). Preventive maintenance for field and laboratory equipment is addressed in the remainder of this section.

11.1 FIELD EQUIPMENT PREVENTIVE MAINTENANCE

The TtNUS equipment manager and the equipment operator will be responsible for ensuring that equipment is operating properly prior to use and that routine maintenance is performed and documented. Field measurements of VOCs will be measured using an electronic instrument. Maintenance procedures for the instrument are detailed in SOP CTO 56-4 Attachment 1. Any problems encountered while operating the instrument will be recorded in the field logbook, including a description of the symptoms and corrective actions taken. If problems with the equipment are detected and service is required, the equipment will be logged, tagged, and segregated from equipment in proper working order. Use of the equipment will not resume until the problem is corrected.

11.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE

Proper maintenance of laboratory instruments and equipment is essential. Depending on manufacturers' recommendations, maintenance intervals are established for each instrument. All instruments will be labeled with a model number and serial number, and a maintenance logbook will be maintained for each instrument. Personnel will be alert to the maintenance status of the equipment they are using at all times. Table 11-1 provides a summary of preventive maintenance procedures performed by Laucks Testing Laboratories, Inc., for key analytical instruments and equipment associated with this project.

The use of manufacturer-recommended grades or better of supporting supplies and reagents is also a form of preventive maintenance. For example, gases used in the ICP instruments are of sufficient grade to minimize fouling of the instrument. The routine use of other supporting supplies from reputable manufacturers will assist in averting unnecessary periods of instrument downtime. An inventory of critical spare parts will also be maintained by the laboratory to minimize instrument downtime.

11.3 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

All field equipment shall be inspected prior to use to ensure that necessary parts are available. Most equipment planned for use in this project is simple with few to no moving parts. Therefore a visual inspection prior to use shall be sufficient to ensure that the equipment is suitable for use. This visual inspection shall occur during mobilization and during each use by the person using the equipment.

Laboratory inspection and acceptance requirements are provided in Section 5 of the Laucks Testing Laboratories, Inc. Quality Assurance Plan, revision 9, dated October 1999. That plan presents the following specifications for inspection and acceptance of supplies and consumables:

- Requirements to follow individual SOP specifications for grades of chemicals necessary to achieve acceptable analytical performance. SOPs are required to detail the necessary grade of chemicals, including compressed gases.
- Requirements to obtain primary chemical standards from reliable sources that use calibrated glassware in the preparation of the standards and to maintain all certificates supplied with the standards. Emphasis is on obtaining NIST-traceable standards where possible.
- Storage of chemical standards in accordance with applicable SOPs and in a manner that preserves their integrity.
- Routine monitoring of de-ionized water and other solvents to ensure that analytical systems, samples, and standards are not contaminated.
- Requirements to record the date received and the date opened on each container of chemical used for analysis.

TABLE 11-1

**PREVENTIVE MAINTENANCE FOR LAUCKS LABORATORIES
ANALYTICAL AND SUPPORT INSTRUMENTS
NSWC CRANE, CRANE, INDIANA
PAGE 1 OF 2**

Instrument	Preventive Maintenance	Maintenance Frequency
HPLC - Energetics	Change filter frit in mixer.	As needed (when pressure builds).
	Change column pre-filter.	As needed (2-3 months).
	Rinse water pump with methanol, filter water, sonicate water intake filter frit.	Approximately weekly.
	Change pump seals.	As needed.
GC/MS – PAHs	Change injection port liner and septum, clip 5-10 cm from front of pre-column, ramp GC oven twice to 310 °C.	Daily or as needed.
	Clean source, install new guard column, clean or replace tubing, replace bottom seal in injection port, replace o-ring in injection port.	As needed.
GC –Heptachlor Epoxide	Swab electron capture (EC) detectors for radioactivity.	Semi-annually.
	Change O ₂ traps on gas lines.	Approx. semi-annually.
	Clean autosampler syringe.	Approx. monthly.
	Change injection port liner and septum.	Approx. every 100 injections.
	Bake system, flush injection port, clip guard column, change analytical column, change carrier hydrocarbon trap.	As needed.
ICP/MS – As and Be	Clean or change air filters, change pump oil.	Semi-annually.
	Clean torch, replace nebulizer tips, replace pump tubing, replace injector, change cones.	As needed.
	Check mass calibration.	Every 2 weeks.
	Check sensitivity.	Daily.

TABLE 11-1

**PREVENTIVE MAINTENANCE FOR LAUCKS LABORATORIES
ANALYTICAL AND SUPPORT INSTRUMENTS
NSWC CRANE, CRANE, INDIANA
PAGE 2 OF 2**

Instrument	Preventive Maintenance	Maintenance Frequency
ICP/AES – Mn	Service Intercooler.	Annually.
	Rinse and clean nebulizer cap and spray chamber.	Monthly or as needed.
	Clean torch, vacuum filters.	Bi-monthly.
	Profile instrument, examine autosampler tubing and replace as needed.	Daily.
	Empty rinse container, fill rinse water reservoir.	As needed.
Refrigerators	Monitor temperature	Daily.
Ovens	Monitor temperature	Daily.
Balances	Certify Class S weights	Annually.
	Routine service by outside party	Annually.
Thermometers	Calibrate against NIST thermometer	Annually.
	Recertify NIST Thermometer	Annually.
Micropipets	Check gravimetrically	Monthly.
	Clean o-rings	As needed.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Compliance with quantitative QC objectives for laboratory accuracy and precision as outlined in Tables 3-1, 3-2 and 3-3 will be evaluated during data validation (Section 9.0). Compliance with completeness objectives for field and laboratory data will be computed. Sections 12.1 and 12.2 present equations to be used for computing accuracy and precision values, respectively. Section 12.3 describes the means and presents the equation for determining completeness. Section 12.4 addresses the overall data assessment process.

In general, data validation requires that data be evaluated batch-by-batch based on the results of quality indicators for the respective batches. Section 12.4 presents additional data quality considerations to be evaluated after data validation. These considerations are designed to incorporate data quality factors that extend beyond evaluation of the simple quantitative estimators for precision, accuracy and completeness.

12.1 ACCURACY ASSESSMENT

Sample collection accuracy cannot be evaluated because there is no standard by which to judge such accuracy. Instead of a quantitative evaluation of sample collection accuracy, compliance with field SOPs as described in Appendix B will be the metric. Background comparisons of data generated by identical sampling and analysis methods incorporate similar biases and are expected to be directly comparable without any adjustments or compensations.

Sample analysis accuracy will be assessed through the use of surrogate spikes, MSs, PDSs, LCSs, calibration check standards, internal standards and blanks. Blanks will be used to infer the potential for positive biases because of contamination. To assure the accuracy of the analytical procedures, prior to preparation for analysis at least 1 of every 20 environmental samples will be spiked with known amounts of target analytes (i.e., MSs). The spiked samples will be analyzed and the concentrations of each target analyte observed in the spiked sample compared to the reported value of the analyte in the unspiked sample determines the %R of the analyte. Control charts are plotted by the laboratory for each target analyte and kept on matrix- and analyte-specific bases. The %R for a spiked sample is calculated by using the following formula:

$$\%R = \frac{\text{Amount in Spiked Sample} - \text{Amount in Sample}}{\text{Known Amount Added}} \times 100 \%$$

As discussed in Section 3.2.3, LCSs and surrogate spikes are also analyzed to assess accuracy. The %R calculation for LCSs and surrogate spikes is:

$$\%R = \frac{\text{Experimental Concentration}}{\text{Certified or Known Concentration}} \times 100 \%$$

12.2 PRECISION ASSESSMENT

As presented in Section 3.1.3, laboratory duplicate samples (for inorganic analyses) and MSD samples (for organic analyses) will be prepared and analyzed at a minimum frequency of 1 per every 20 environmental samples per matrix. As described in Section 3.1.2, field duplicate samples also will be collected at a minimum frequency of one per 10 environmental samples per matrix. The RPD between a sample or MS (Sample 1) and its duplicate or MSD (Sample 2) is calculated using the following formula:

$$RPD = \frac{|\text{Amount in Sample 1} - \text{Amount in Sample 2}|}{0.5 (\text{Amount in Sample 1} + \text{Amount in Sample 2})} \times 100 \%$$

12.3 COMPLETENESS ASSESSMENT

Completeness for this project will be determined based on the number of sample results for each target analyte and each sample type that are usable as determined through data validation and data assessment. Data values rejected during data validation (indicated by an "R" flag) will be considered unusable unless additional review and documentation by one or more technical team members demonstrates that the rejection is erroneous. To monitor completeness, the number of usable, valid results for each soil type and analyte will be counted and compared to the completeness objectives in Sections 3.3.2 and 3.3.3.

Percent completeness will be calculated using the following equation:

$$\% \text{ Completeness} = \frac{(\text{number of valid measurements})}{(\text{number of measurements planned})} \times 100\%$$

12.4 DATA ASSESSMENT

The assessment of data obtained from this investigation is a critical part of determining what the next step in data collection and decision making should be. It must be determined if the data are of appropriate type, quality, quantity and representativeness to support the project objectives. The effect of the loss of data deemed unacceptable for use, for whatever reason, will be evaluated.

12.4.1 Reconciliation with Data Quality Objectives

Field data will be examined immediately after generation for errors. Laboratory data will be examined upon receipt from the laboratory in a cascading series of evaluations. The first step will be a data verification and validation as described in Section 9.0.

After data validation, the data will be reconciled with DQOs to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described in Section 12.1 through 12.3, a series of inspections and statistical analyses will be performed to estimate several of the data set characteristics. The statistical evaluations will include estimates of data distribution characteristics and simple summary statistics for target analytes, including the maximum concentration, minimum concentration, number of samples exhibiting no detectable analyte, the number of samples exhibiting detectable analytes, and the proportion of samples with detectable and undetectable analytes. These inspections and statistical analyses will be designed to:

- Identify deviations, if any, from the field sampling SOPs (inspection)
- Identify deviations, if any, from the laboratory analytical SOPs (inspection)
- Identify deviations, if any, from the QAPP (inspection)
- Identify deviations, if any, from the data validation process (inspection)
- Identify and explain the impacts of elevated RLs (inspection)
- Identify unusable data (i.e., data qualified as "R") (inspection)
- Evaluate project assumptions such as "field duplicate RPD > laboratory duplicate RPD" (inspection/statistics)

- Characterize data set distributions (e.g., Shapiro-Wilk W test) (statistics)
- Identify unanticipated data set characteristics such as a laboratory variance greater than the sampling variance (i.e., ANOVA, *t*-test) (statistics)
- Identify and evaluate potential data outliers (95% confidence goodness-of-fit test on probability plot data). The plotted data will be transformed, if necessary, depending on the observed distribution. (statistics)
- Evaluate adherence to investigation objectives and decision rules (inspection/statistics)
- Ensure completion of corrective actions (inspection)
- Evaluate effects of deviations from planned procedures and processes on the interpretation and utility of the data (inspection/statistics)
- Identify the existence of remaining data gaps (inspection/statistics)

For statistical comparisons and mathematical manipulations, analytes that are not detected at the applicable sample-specific RL will be represented by a concentration equal to one-half the sample-specific RL.

Statistical tests for outlier validity will be based on "Procedural Guidance for Statistically Analyzing Environmental Background Data" (NFEC, 1998). Potential outliers will be removed if a review of field and laboratory documents indicates that the results are true outliers. If no identifiable reason for the outlier can be identified, the datum will not be removed from the data set.

If necessary, investigation objectives may be revised in anticipation of additional data collection.

12.4.2 Statistical Soil Background Comparisons

Three-dimensional kriging at a 50% confidence level will be used to establish the initial estimates of the extent of contamination, if any. Inspection of the kriged data will be used to determine whether the observed trends are sensible in the context of the conceptual site model. If these trends are unreasonable, another confidence level may be selected until the kriged results are sensible. Such a

need will be based on professional judgment, as the concentration gradients cannot be estimated in advance of sampling.

Recognizing that the background analyte concentrations may differ among soil grain sizes, depositional environments and sampling depth, the background analyte concentrations compared to kriged concentration boundaries will represent, as closely as is reasonable, the distinguishing sample characteristics of the soils within the kriged volume. This may entail the use of different soil background concentrations for different regions of the kriged volume if the soils differ significantly within the volume. An attempt will be made to classify the soil data in a way that provides the greatest chance of detecting differences between site and background samples. The soils of this investigation will be classified to the same levels of soil differentiation as those of the background investigation.

Data sets will also be inspected for spatial variations that might qualify the suitability of the data sets for use. For example, a general decreasing spatial trend of the concentration of one or more chemicals could indicate a spatially related geochemical difference in background concentrations that should be considered when using the background data set.

Professional judgment may play a significant role in these data interpretations because of the potential complexity of the data distributions. For example, experienced geologists and chemists may interpret the data in terms of fundamental geochemical and chemical principles. The overall objective of the data reviews will be to obtain an assessment of the reasonableness of the data sets and to evaluate whether project objectives have been achieved.

The TOM shall bear ultimate responsibility to ensure that data are evaluated in a manner consistent with project objectives. All data, including statistical outliers, will be retained as part of the final record even though they may not be used in decision making. Data identified as outliers by statistical testing will be examined for errors (i.e., mistakes in conversions, transpositions, etc.). Incorrect data will be eliminated from the data set if errors or mistakes are the cause for values being outliers. If mistakes or errors are not noted following evaluation of the suspect data, they will be included as acceptable values, even if they were identified as outliers by the statistical test.

13.0 CORRECTIVE ACTION

Under the TtNUS QA/QC program, it is required that any and all personnel noting conditions adverse to quality should report these conditions immediately to the TOM and QAM. These parties, in turn, are charged with performing root-cause analyses and implementing appropriate corrective action in a timely manner. It is ultimately the responsibility of the QAM to document all findings and corrective actions taken and to monitor the effectiveness of the corrective measures performed. A brief summary of corrective actions for some specific field and laboratory QC check samples is presented in Section 3.0, Table 3-2.

13.1 FIELD CORRECTIVE ACTION

Field nonconformances or conditions adverse to quality must be identified and corrected as quickly as possible so that work integrity or product quality is not compromised. The need for corrective action may arise based on deviations from project plans and procedures, adverse field conditions, or other unforeseen circumstances. Corrective action needs may become apparent during the performance of daily work tasks or as a consequence of internal or external field audits.

Corrective action may include resampling and may involve amending previously approved field procedures. Minor modifications to field activities, such as the collection of additional samples, will be initiated at the discretion of the FOL, subject to onsite approval by NSWC Crane personnel. Major modifications, such as the elimination of a sampling point or other situations that affect compliance with or achievement of DQOs, must be approved and documented via a Field Task Modification Request (FTMR). Approval of the corrective action will be obtained by the U.S. Navy (in conjunction with U.S. EPA Region 5 and IDEM). The FOL is responsible for initiating FTMRs. A FTMR will be prepared for all deviations from the project plan documents, as applicable. An example of a FTMR is provided in SOP CTO 56-4 (Appendix B). Copies of all FTMRs will be maintained with the onsite project planning documents and will be placed in the final evidence file.

13.2 LABORATORY CORRECTIVE ACTION

In general, laboratory corrective actions are warranted whenever an out-of-control event or potential out-of-control event is noted. The specific corrective action taken depends on the specific analysis and the nature of the event. Generally, the following occurrences alert laboratory personnel that corrective action may be necessary:

- QC data are outside established warning or control limits
- Method blank analyses yield concentrations of target analytes above acceptable levels
- Undesirable trends are detected in spike %Rs or in duplicate RPDs
- There is an unexplained change in compound detection capability
- Inquiries concerning data quality are received
- Deficiencies are detected by laboratory QA staff during audits or from PE sample test results

Any corrective action taken above the analyst level that cannot be performed immediately at the instrument will be documented. Corrective actions typically are documented for out-of-control situations on a Corrective Action Form or an Out-of-Control Event Form. Copies of the forms used by Laucks Testing Laboratories, Inc., are included as Appendices 1 and 3 of SOP LTL-1008, which is in Appendix C of this QAPP. Further detail describing the system used by Laucks Testing Laboratories, Inc., to identify, document, and resolve out-of-control events is provided in SOP LTL-1008.

Laboratory corrective actions must be documented and included as part of the Final Evidence File. Major corrective actions that do not bring DQO-related non-conformances into conformance with project DQOs shall be identified to the TtNUS TOM who will advise all levels of project management in accordance with Section 14.0 of this QAPP.

13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT

The need for corrective action may become apparent during data validation, interpretation, or presentation activities. The performance of rework (i.e., resampling or reanalysis), the institution of a change in work procedures, or the provision of additional/refresher training are possible corrective actions relevant to data evaluation activities. The TOM will be responsible for approving the implementation of a corrective action and ensuring that it is documented appropriately. Analytical data may be qualified during data validation to alert data users to the potential that particular analysis results are potentially deficient relative to expected performance standards. Such validation practices are described in Section 9.2. When conducting data assessment for project decision making, a number of situation-dependent qualifications on data or decisions are possible. The number of possible situations or conditions precludes enumeration of all possible corrective actions, however the approach used to identify and impose such qualifications is described in Section 12.4.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

QA reports to management will be provided in four primary formats during the course of this investigation: data validation reports, reports summarizing accomplishments and QA/QC issues during the field investigation, project-wide progress reports, and laboratory QA reports. The frequencies of report generation, report content, report preparer, and report recipient(s) are summarized in Table 14-1.

Data validation reports will address all major and minor laboratory noncompliances as well as noted sample matrix effects. In the event that major problems occur with the analytical laboratory (e.g., repeated or extreme holding time exceedances or calibration noncompliances, etc.), the Data Validation Manager will notify the TOM, QAM, Program Manager, Technical Coordinator, and Laboratory Services Coordinator. Such notifications (if necessary) are typically provided via internal memoranda and are placed in the project file. These reports contain a summary of the noncompliance, a synopsis of the impact on individual projects, and recommendations regarding corrective action and compensation adjustments. Corrective actions for major noncompliances are initiated at the program level.

The FOL will provide the TOM with daily oral field progress reports during the course of the sampling event. These reports will explain accomplishments, deviations from the QAPP, upcoming activities, and a QA summary. The TOM provides a monthly progress report to the Navy which addresses the project budget, schedule, accomplishments, planned activities, and QA/QC issues and intended corrective actions.

The subcontracted analytical laboratories will provide a QA report to TtNUS if QC limits are updated or if other significant plan deviations resulted from unanticipated circumstances. Because IDLs/RLs, as applicable, will be included in the analytical data packages for NSWC Crane samples, it is not necessary for the laboratories to include updated IDLs/RLs in their QA reports unless the updates result in RLs which exceed RBTLs.

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TABLE 14-1
SUMMARY OF REPORTS
NSWC CRANE, CRANE, INDIANA

Report	Content	Preparer	Frequency of Submittal	Recipient(s)
Data Validation Report	All major and minor laboratory noncompliances as well as noted sample matrix effects	Data Validation Manager or designee	Per SDG	TOM, project file
Major Analysis Problem Identification Report (internal memorandum)	Notification of persistent or major problems with analytical laboratory performance. Summary of the noncompliance(s), a synopsis of the impact on the project, and recommendations regarding corrective action and compensation adjustments	Data Validation Manager or designee	When persistent analysis problems are detected	TOM, QAM, Program Manager, Technical Coordinator, Laboratory Services Coordinator, project file
Project Monthly Progress Report	Summary of the project budget, schedule, accomplishments, planned activities, and QA/QC issues and intended corrective actions.	TOM	Monthly for duration of project	Navy, project file
Field Progress Reports	Explain accomplishments, deviations from the FSP, upcoming activities, and a QA summary.	FOL	Daily, oral, during the course of sampling	TOM
Laboratory QA Report	Summary of updated QC limits or significant deviations from planned activities/performance.	Laucks Testing Laboratories, Inc.	When QC limits are updated or when other significant plan deviations result from unanticipated circumstances	TtNUS, project file; U.S. EPA Region 5, if changes in RLs cause them to exceed RBTls or if QAPP deviations impact DQOs

SDG = Sample Delivery Group
TOM = Task Order Manager
QAM = Quality Assurance Manager
RL = Reporting Limit
FOL = Field Operations Leader

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